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# POWER

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# Easy to Keep Records

IN THE days before electricity became so common there was some excuse for the blind way in which power plants were run.

Boiler-room apparatus was crude and boiler-room labor not of a sort to keep intelligent records. Few plant owners or engineers knew, except from the railroad or cargo weights, how much coal they burned or how much water they evaporated.

When it came to knowing how much power was produced, the case was a lot worse. The only practicable means of measuring it was the steam engine indicator, and this gave, with measurement and computation of its diagrams, only the power that was being developed on the stroke during which they were taken.

It was too much work to take many of them during the day, and those taken gave but an approximate idea of the average of a varying load.

The replacement of belts and gearing by electricity as a means of power distribution has reduced this part of the problem to a delightful simplicity.

When the engine or turbine runs a generator, the output can be continuously measured by instruments of precision that require but a reading.

The most difficult part of the measuring process has become the easiest.

And additional instruments will indicate the proportions of the power used by different departments and the losses in transmission.

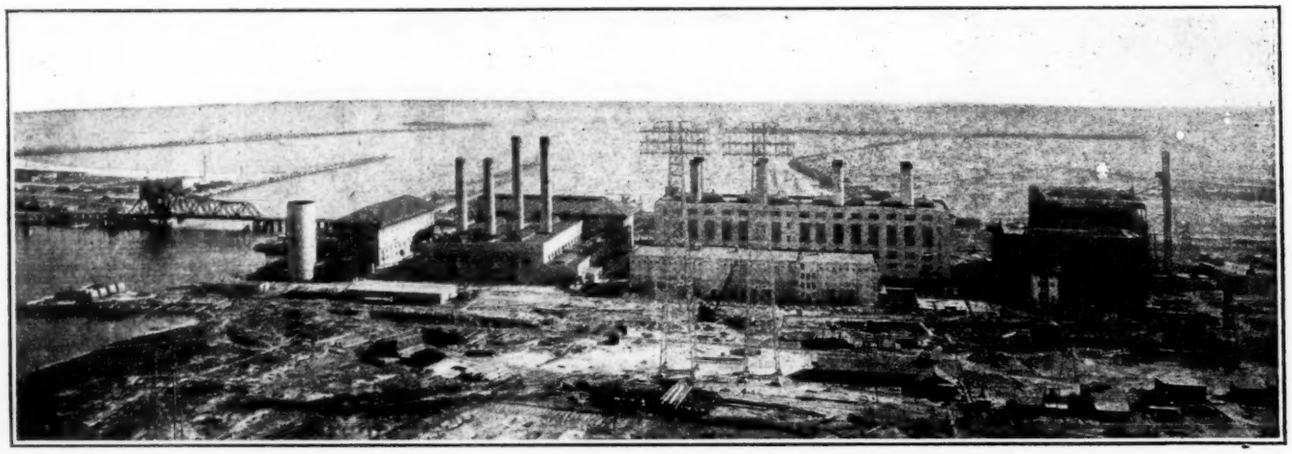
The measurement of the power having thus been made easy, the completion of the record by measuring the fuel and water becomes better worth while and more interesting.

And here better methods and apparatus are available; improved water meters, steam-flow meters, coal-weighing appliances, etc.

If one can have the weight of coal fired, the weight of ashpit refuse, the water evaporated, the steam to the engine and the current produced, one can go a long way toward estimating comparative efficiency and telling whether performance is keeping up or falling off.

Even the small-plant owner will find the investment in the simple apparatus to determine these quantities and the keeping and study of the records a profitable one.

F. R. Low



*General view, looking south, of Long Beach steam plants*

Long Beach Harbor channel entrance at left; new No. 3 plant being constructed at right; Pacific Ocean in background; intake for cooling water tunnels at extreme left.

# Steam Plant Development of Southern California Edison Company

By RAYMOND WILCOX*

**THIRD steam plant of a company that eventually will have capacity of one million kilowatts now under way. Tandem-compound turbine rated at 94,000 kw. will be one of the largest in operation and boilers having individually more than 34,000 sq.ft. of surface will be the largest used for power purposes. Flow diagrams for the three steam stations show the advance made in power-plant design**

EARLY in 1928 the Southern California Edison Company will place in commercial operation new generators with a total capacity of 170,000 kw. Two hydro units of 40,000 kw. each will be installed in a new plant to be added to the Big Creek group of hydro plants in the High Sierra Mountains. One 90,000-kw. steam turbine unit will be installed in a steam plant to be added to the group of steam plants on Terminal Island at Long Beach. The plans for this new plant call for an ultimate installation of eight units with a total capacity of a million horsepower. The first unit is being installed and the second has been ordered.

In addition to this large increase in generating capacity, the company will extend its 220,000-volt transmission lines to connect these two generating centers. When extended, the line will total 280 miles in length. This high-tension transmission line is the backbone of the Edison system, which covers an area of 55,000 square miles. Following, as it does, so closely upon the increases in capacity made by this company in the last few years, this new construction is evidence of the rapid growth of central and southern California, particularly in the industrial field.

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Facing the Pacific Ocean and adjacent to the Long Beach harbor channel is the location of a group of steam plants of the company to which a third plant is now being added. Condensing water for all the plants is taken from the channel and discharged across the beach to the ocean. Natural gas from the near-by oil fields and fuel oil from the refineries are delivered to the plants by pipe lines laid across the channel bed. The City of Long Beach, which has grown to 140,000 population, offers desirable living conditions for the operating forces. It may be of interest to summarize the equipment of each plant and by means of flow diagrams trace the development.

Designed and built in 1911 by the company's own engineers, the first plant contains three vertical turbine-generator units with base condensers. The total capacity of these machines is 47,000 kw. The boilers are of Stirling type, each having 8,500 sq.ft. of surface. They are oil fired, using steam atomizing burners.

In 1924, during the unprecedented water shortage in California, three horizontal turbine-generator units were added to this plant, bringing up the total capacity to 70,000 kw. The flow diagram in Fig. 1 is typical for the vertical units. Known as No. 1, this plant is maintained in good condition as a cold stand-by. Starting

cold, the plant has been brought on the line in one hour and ten minutes. However, this speed in starting is required only in emergencies.

### Long Beach Steam Plant No. 2

In the Long Beach group the second plant was designed and constructed by Stone & Webster. The adverse water power conditions required that the first two

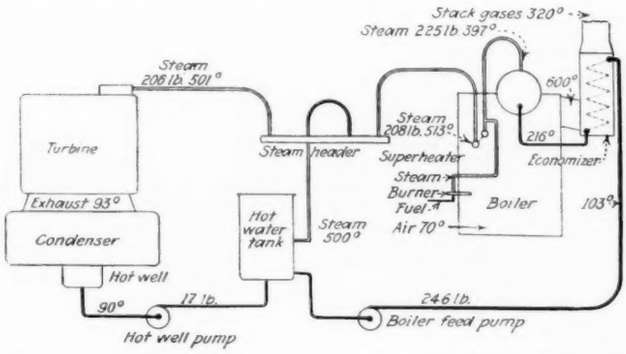



*Fig. 1—Flow diagram of unit No. 3 of Long Beach Steam Plant No. 1*

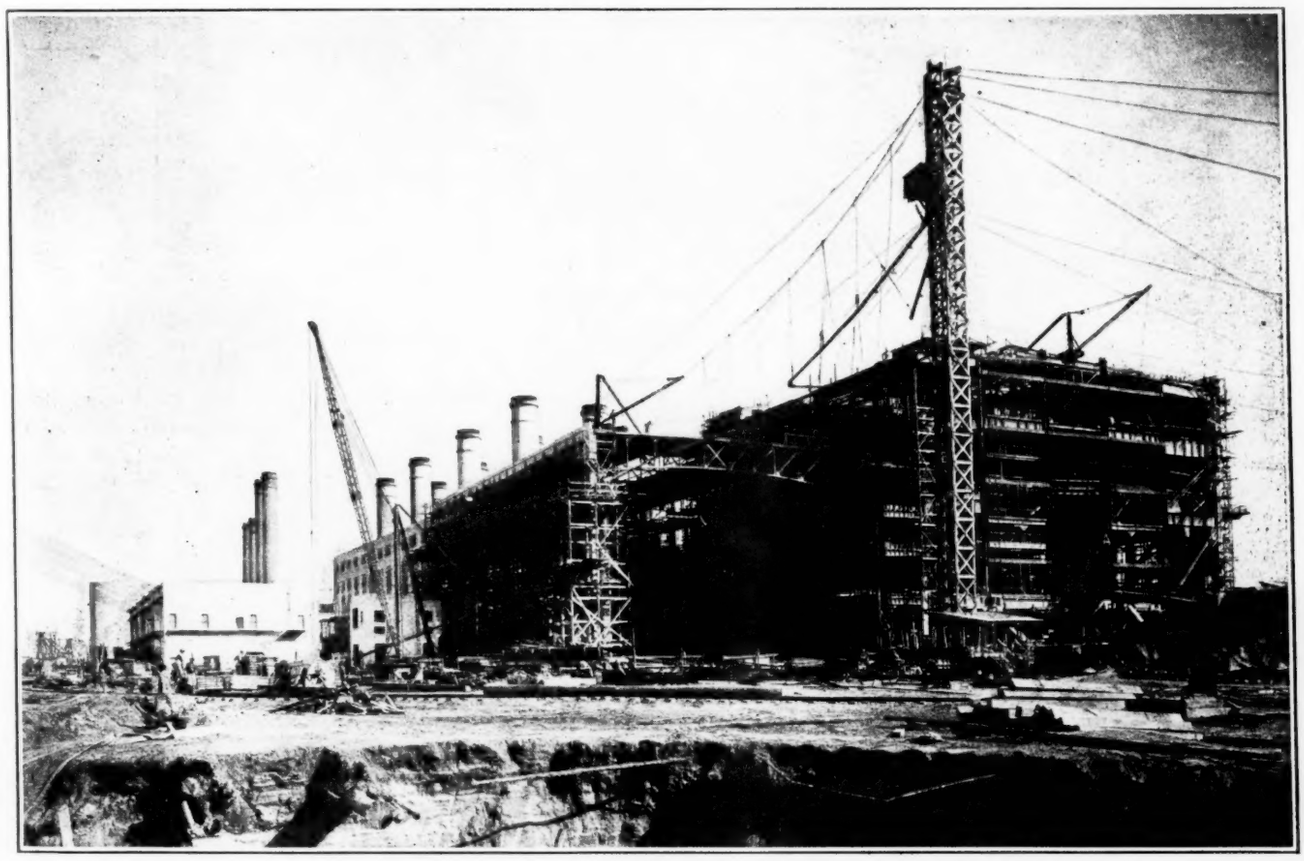
units be installed and ready for commercial operation in the shortest possible time. A construction record was established when the first unit was placed in service during December, 1924, just 10½ months after ground was broken for the construction work. The initial installation in this station described in *Power*, Feb. 17, 1925, contained two units rated at 35,000 kw. each. In 1926 a third machine of 50,000 kw. capacity was added, a detailed description of this unit appearing in the *Journal of Electricity*, Sept. 1, 1926.

Extended operating experience with these three machines has demonstrated that they are capable of carrying continuously at good efficiency considerably larger loads than their nameplate ratings. The plant can carry continuously 145,000 kw. and is now so rated as a generating station. This performance is evidence of the well-balanced design of the plant and the high quality of the equipment. The flow diagrams in Figs. 2 and 3 show the stage-extraction, feed-water heating system used.

### The New Long Beach Plant No. 3

This new plant, in which the first unit is now under construction, will have many interesting features. The performance of the tandem-compound turbine and the large boilers will be watched with interest, and the combination of this large equipment with the 220,000-volt outdoor switching equipment at the seashore will offer opportunities for engineers to observe much that is new and interesting.

Rated at 94,000 kw., the turbine will be one of the largest in operation. The high-pressure section will take steam at 400 lb. pressure and 725 deg. F. total temperature. The low-pressure section will be of double-flow arrangement. On the same shaft with these two



*View looking from temporary end of new Long Beach Steam Plant No. 3*
Turbine room is 80 feet wide; auxiliary electric bay is between turbine room and boiler house.

sections of the turbine will be mounted the 90,000-kw. main generator and a 4,000-kw. house generator. The over-all length of the unit will be 103 ft.

The low-pressure section of the turbine is provided with two exhaust openings, each of these openings being connected to two vertical condensers bolted solidly to the turbine and resting upon sliding feet supported by concrete piers. The turbine platform will be only 15 ft. above the condenser floor, and the four vertical condensers surrounding the unit will be higher than the turbine. The air removal jets and air coolers will be up on the turbine platform level, as will be the feed-water heaters. This arrangement of equipment will present a turbine room quite different in appearance from the ordinary, and one that will have many operating advantages.

Cooling water will flow upward, making one pass through the tubes of the condensers. The condensing water piping will be arranged so that the flow through any one condenser can be reversed to wash the débris out of the tubes. Reheat hotwells are provided to counteract the refrigeration of the condensate. The arrangement of these hotwells is shown diagramatically in Fig. 4, a flow diagram for the new plant.

### Condensing Water Pumps at Low Level

To prevent the liberation of air in the condenser cooling water, the circulating pumps have been placed at a low level. The center lines of the pump shafts will be at mean low tide. This location eliminates any suction lift except at infrequent tides. The two circulating pumps will have a capacity of 165,000 gallons per minute.

The high head required on the condensate pumps made the use of a standpipe and surge tank impracticable. An automatically controlled makeup and draw-off system for maintaining a constant water level in the reheat hotwells has been devised. A Smoot control system actuated by floats connected to the hotwells will admit makeup water from the distilled water tank to the hotwells when needed and draw-off water from the condensate line when there is an excess. Motor-operated bypass valves are provided for manual control of the water level in the event of failure of the automatic control.

### Feed-Water Heating System

From the flow diagram, Fig. 4, the reader will see that steam is extracted from four stages of the turbine for feed-water heating. The two low-pressure heaters are of vertical type. The evaporator condenser and the two high-pressure heaters are horizontal. Under the head produced by the hotwell pumps the condensate will flow through the low-pressure heaters directly to the suction of the boiler-feed pumps which will discharge through the two high-pressure heaters to the boilers. Every piece of equipment in the feed-water heating system can be bypassed by means of bypass valves of special design that essentially are double-seated globe valves.

Makeup water to the evaporators is taken from wells and is treated in zeolite water softeners. A continuous blow-down system will be used to keep the concentration

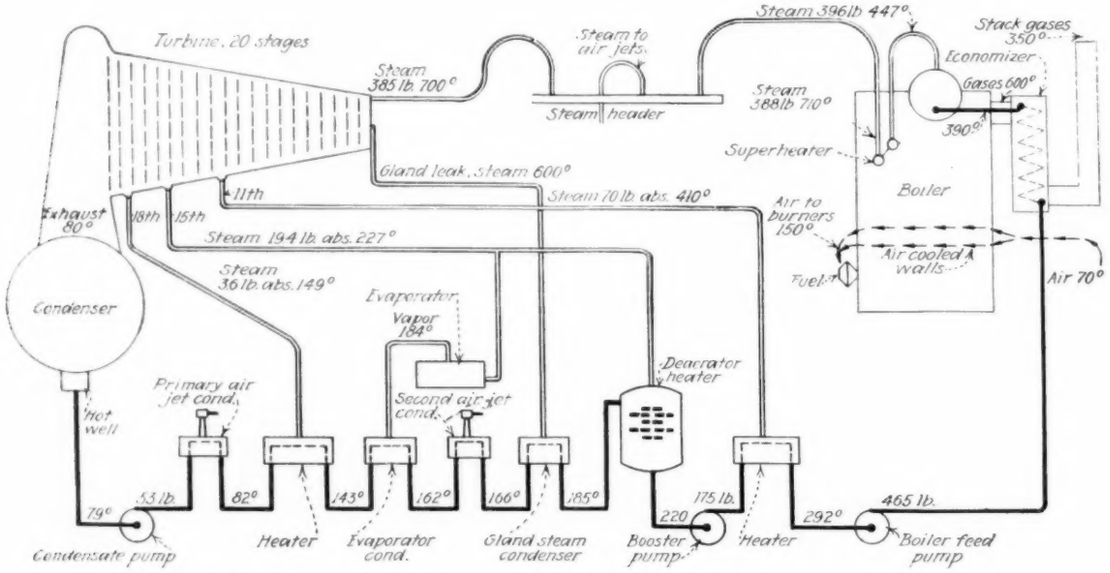



*Fig. 2—Flow diagram of units Nos. 7 and 8 of Long Beach Steam Plant No. 2*

in the evaporator shells always below the point where priming takes place. Basing the expected makeup on the operating experience gained in plant No. 2, it will be necessary for the evaporator to deliver an amount of vapor equal to about one-half of one per cent of the steam required by the turbine. The capacity of the evaporator, however, is equal to $2\frac{1}{2}$ per cent.

### Largest Boilers for Power Purposes

For the first unit boilers are being installed that will be the largest single boilers ever built for power purposes. They are designed for 460 lb. steam pressure. The heating surface in each boiler will total 34,168 sq.ft. and the maximum evaporating capacity expected of each boiler will be 450,000 lb. of steam per hour. They will be equipped with air preheaters. The furnaces will be constructed entirely of refractory faced blocks mounted on water-cooled tubes. The complete furnace and boiler will stand 65 ft. high. The furnaces are provided with hopper bottoms constructed of water-cooled tubes and

blocks. Space has been provided for ash sluiceways and equipment necessary for future use of coal in powdered form for fuel.

Superheaters will be of the three-pass, convection type, placed in an interdeck location. They are expected to deliver steam at a temperature of 750 deg. F. at 350 per cent of boiler rating. The tubes in the last pass of the superheater will be of chromium alloy steel to withstand the high temperatures encountered.

Insulated-front, wide-range combination oil and gas burners to the number of 20 per boiler will be located in the front wall of the furnace. A complete automatic boiler control system will be used to regulate the forced- and induced-draft fans and dampers and the fuel supply automatically. Two forced-draft fans and one induced-draft fan per boiler are being provided, the fans to be driven by brush-shifting variable-speed motors.

Careful attention has been given to the detail design of all piping and valves to insure reliability and minimize maintenance. Steam strainers will be placed at each superheater outlet. Experience has shown the desirability of these strainers to prevent pieces of metal inadvertently left in the boiler or superheater from being carried by the steam to lodge in some valves or drain pocket. The main steam piping will be made from im-

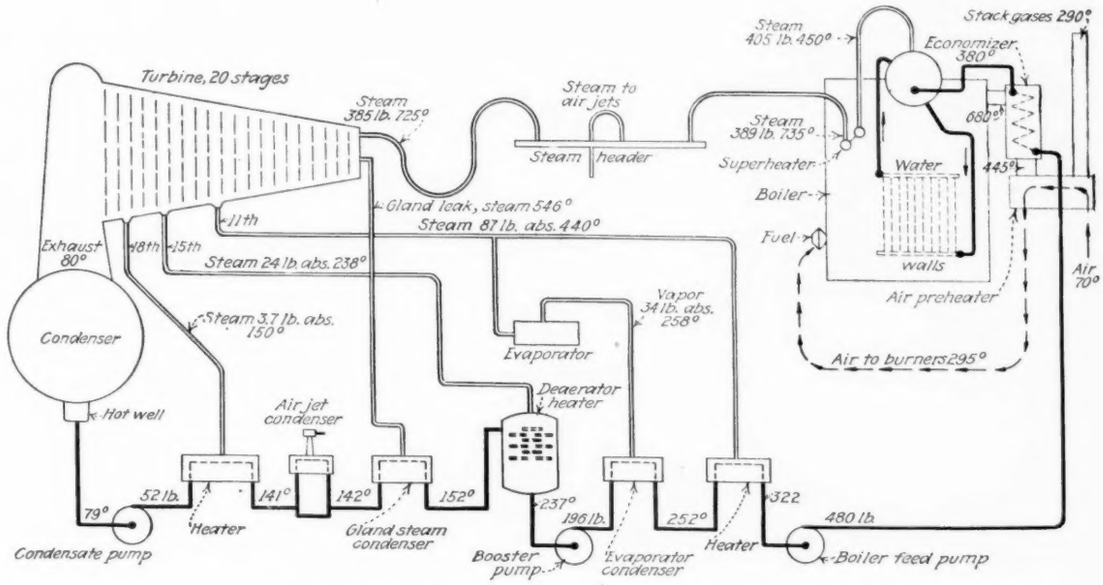



*Fig. 3—Flow diagram of 50,000-kw. unit in plant No. 2*

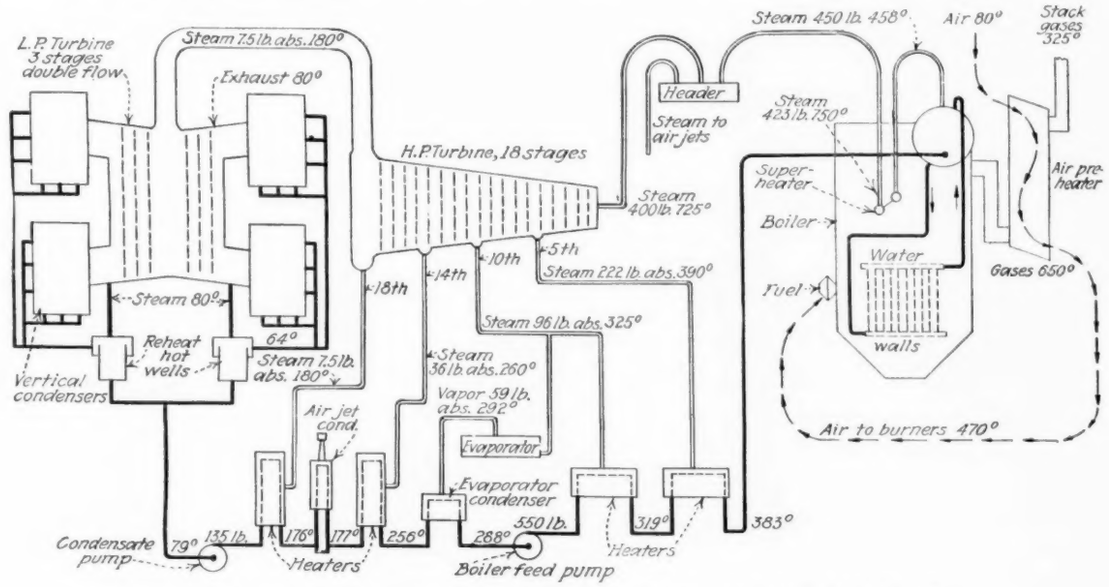



*Fig. 4—Flow diagram of the first 90,000-kw. unit in plant No. 3*

ported seamless steel tubing. The steam lead to the turbine will consist of two 18-in. pipes connecting to a 26-in. throttle valve. All joints in the high-pressure piping will be of the Van Stone lap and Sargol seal type. The steam header will be forged from a single steel billet.

No special test equipment has been included in the layout of this power plant, but an unusually complete equipment of recording instruments will be provided to enable the operators to check the performance of every piece of equipment and maintain the proper operating conditions. The company's engineers believe that the average daily operating economy of the station and of the turbine, boilers and auxiliaries should be the measure of their efficiency, rather than the results obtained from any staged tests.

### Bi-Metal Valve Trim and Motor Operating Mechanism

All gate valves for high-pressure steam and boiler feed lines will be 600-lb. standard with chrome nickel steel bodies, and fitted with stainless steel stems and seats. The facings of the solid disks will be of Monel metal. This bi-metal trim was decided upon in the belief that it will prove more satisfactory than either all stainless steel or all Monel metal trim.

The mechanism for all motor-operated valves is constructed without clutches of any kind, as this simple, positive type of mechanism is preferred. The valve manufacturer has been required to guarantee that his valves will not be ruptured by the closing of any valve under power against any foreign substance that may have become lodged on the seat. All the forged-steel globe valves and all boiler blowoff valves likewise will be provided with stainless steel Monel metal combination trim.

### Buildings and Boilers Designed to Resist Earthquakes

Buildings comprising the new plant will be of monumental design and of steel-frame, reinforced-concrete construction. All the foundations are supported upon wooden piling. Because of the many departures from the conventional power-plant arrangement much study has been given to the design of the buildings and interiors to secure a pleasing appearance. No ornamentation, however, has been provided that is not justified by utility.

The floors of the turbine room, the condenser pit, the firing floor of the boiler house and the oil pump rooms will be of quarry tile. All other floors will be specially hardened, colored and waxed. The housekeeping standards of the company's operating department require that the floors shall always be kept spotlessly clean.

The possibility of earthquake has been anticipated, and all structures, including the boiler furnaces, the superimposed concrete stacks, the turbine and condenser supports, have been designed to resist the effects of seismic disturbances. California weather compelled special consideration to be given to ventilation. The problem was simplified in the boiler house by placing the forced-draft fans above the boilers. The turbine room will be daylighted and ventilated by a three-way motor operated skylight. Sand-tight air inlet louvers located below the side windows also provide for the turbine room ventilation.

The design and construction of Long Beach Steam Plant No. 3 is being carried out by Stone & Webster, Inc., under the general supervision of the Department of Engineering Design of the Southern California Edison Company.

## Steam as a Trespasser

By Arthur L. H. Street

WHERE the owner of a steam plant so discharges steam that it escapes to adjacent property and injures a person there, liability in damages results, holds the Massachusetts Supreme Judicial Court in the case of Buckley vs. Arthur J. Hickey Family Laundry Company, 158 North Eastern Reporter, 769.

Defendant company maintained a radiator exhaust pipe projecting from one side of its plant in Boston. The pipe was ten or twelve inches long and nearly three feet above the ground, extending about to defendant's property line. The steam was emitted from this pipe intermittently and was projected over an adjoining lot, which was owned by a third person. Children habitually played on the lot, and plaintiff, a five-year-old boy, was standing with his back to the pipe when he was scalded by an emission of steam from the pipe. He had been sent by his mother to his grandmother's house near-by. Upholding a verdict in plaintiff's favor, the court said:

"Whether the mother was negligent in allowing the child to go unattended to his grandmother's, and, if not, whether the child exercised the care for his own safety that should be exercised by a child of his age was for the jury to decide. . . . There was no evidence to support the defendant's contention that the jury could have found that it had permission to project steam over the vacant lot; and the ruling of the trial judge that the defendant in doing so was a trespasser was right.

"There was no evidence of wanton or willful misconduct on the part of the defendant; its liability does not depend upon proof of such misconduct. The defendant's duty toward children trespassing on its own property is very different from its duty to children on land of another in which neither party has any rights. . . .

"The question of the defendant's negligence was properly submitted to the jury: it was for them to decide whether the defendant in view of the knowledge it had that the lot was used by children as a playground, sometimes in the immediate vicinity of the pipe, reasonably should have foreseen and guarded against injuries from steam to children who might be on the lot."

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Air Infiltration Through Metal Windows—The Research Laboratory of The American Society of Heating and Ventilating Engineers has completed a study of air infiltration through metal windows. The investigation established the air infiltration through the windows tested for various air velocities and window conditions. At a wind velocity of 15 miles per hour the air leakage through a non-weatherstripped window, unlocked, was found to be 92.5 cu.ft. per hour per foot of crack. The infiltration loss through such metal windows can be reduced about 10 per cent by locking and an average additional 56 per cent by applying weatherstripping of the types suited to the locked window. The application of leakage retarding devices to metal windows of the type studied can be accompanied by an average reduction in radiation installed to meet the heating requirements in zero weather with a 15-mile wind, of 0.28 sq.ft. or foot of crack around the sash. Data collected under natural wind pressures in an actual building are practically the same as those collected for artificial wind pressures.

# Combustion Control Formulas

## *VI—Analysis of Heat Loss in Flue Gas*

By E. A. UEHLING
*M. E., Dr. of Engineering*

IN THE operation of any boiler there is always a large amount of heat carried away in the dry flue gas. A considerable percentage of this heat loss is unavoidable and cannot be prevented, while the remaining portion can, to a large extent, be prevented, and is due to poor combustion and dirty boiler heating surfaces. The unpreventable loss is the heat that would be contained in the flue gas if complete combustion of the fuel took place with the theoretical quantity of air and the gas left the boiler at a temperature equal to the temperature of the water in the boiler.

The total sensible heat in the dry flue gas, as derived in Article V of this series, is equal to, $a$, $X \times T$, where $T$ is the temperature of the gas leaving the boiler and $X = 0.24 \times \frac{58.46}{CO_2}$, the heat loss per degree of flue-gas temture.

IN THIS analysis of heat losses in the flue gas the author derives a method for determining the controllable heat loss, which he divides in two parts, for one of which the fireman is responsible, while for the other part the boiler cleaner is responsible.

When the fuel is completely burned with the theoretical minimum weight of air required, the maximum per cent of $CO_2$, $MCO_2$ will result and $0.24 \times \frac{58.46}{MCO_2} = X_m$, will be the theoretical minimum amount of heat that the gas, produced in burning one pound carbon unit of fuel, can contain per degree of temperature. It is also evident that the temperature of the gas $T$ cannot be reduced by the boiler below the temperature of the water in the boiler $T_w$, therefore, the heat component, $b$, $X_m \times T_w$, represents the minimum B.t.u. per unit of fuel burned to which the sensible heat in the dry gas can be reduced in passing through the boiler. This amount of heat is therefore unavailable to the boiler and, hence, uncontrollable. The available controllable sensible heat in the dry gas is the difference between this component and the total sensible heat and is, $c$, $(X \times T) - (X_m \times T_w)$ = B.t.u. of controllable heat per pound carbon unit of fuel burned.

The controllable sensible heat in the dry gas depends on two factors, excess air and excess temperature. Since $X_m$ is the theoretical minimum—that is, the uncontrollable value—of $X$, $X - X_m$ = B.t.u. of controllable sensible heat in the gas per degree of temperature per unit of fuel burned, and since $T_w$ is the theoretical minimum at which the temperature of the gas can leave the boiler, we have component, $d$, $(X - X_m) \times T_w$ = B.t.u. of controllable heat loss due to excess air alone. Excess temperature does not enter into this heat loss component. The difference between $T_w$, the theoretical minimum temperature to which the gas can be reduced in passing through the boiler, and $T$, the actual temperature at which it leaves the boiler, is the controllable temperature. Since $X_m$ is the value of $X$ when the fuel is burned with the theoretical weight of air required for a complete combustion, that is, without excess air component, $e$, $(T - T_w) \times X_m$ = B.t.u. of controllable sensible heat loss due to excess temperature alone.

The two heat loss components $d$ and $e$ do not represent all the controllable heat contained in the flue gas, because component $d$ does not include the excess temperature $T - T_w$ and component $b$ does not include the increased weight of gas due to excess air $X - X_m$. This loss is represented by component $f$, $(X - X_m) \times (T - T_w)$ = B.t.u. loss of controllable sensible heat due to excess air and excess temperature. The sum of the heat loss components $d + e + f$ must always be equal to the total controllable sensible heat carried to waste by the dry gas.

Assuming complete combustion the three heat loss components represent all the sensible heat it is theoretically possible to save, except the practically negligible sensible heat contained in the water vapor; but since complete combustion is the exception rather than the rule, there is a fourth component representing potential heat, heat in the form of combustible gases of which CO is the index. The potential heat is given by formula 2 $10{,}160 \times \frac{CO}{CO + CO_2}$. Letting $\frac{CO}{CO + CO_2} = Y$, component $g$ becomes, $10{,}160 \times Y$ = B.t.u. of potential controllable heat loss due to incomplete combustion. This heat loss component is quite independent of the temperature, but varies inversely as the per cent of $CO_2$. The higher the per cent of $CO_2$ the lower will be the loss due to a given per cent of CO.

To give the engineer a clear understanding of the practical value of the heat loss analysis, the formulas for the heat components will be applied to two cases burning bituminous coal, Case $A$ with 14.8 and Case $B$ with 9.2 per cent $CO_2$. It will also be assumed that the average steam pressure is 175 lb. By consulting the respec-

tive curves in Article V and solving for $X_m$, the heat loss factors are found to be as follows:

| | Case A | Case B |
|---|---|---|
| $CO_2$, per cent | 14.8 | 9.2 |
| $X$, B.t.u. | 4.2 | 6.6 |
| $Xm$, B.t.u. | 3.38 | 3.38 |
| $T$, deg. F. | 500 | 575 |
| $Tw$, deg. F. | 377 | 377 |
| $CO$, per cent | 0.30 | 0.15 |
| $Y$, lb. carbon contained in CO | 0.0212 | 0.0162 |
| Excess air, per cent | 25 | 100 |

Inserting the value of these factors in the respective formulas for determining the several heat loss components, the results given in Tables I and II are obtained. A clear conception of the heat loss components and their

TABLE I—ANALYSIS OF HEAT LOSSES, CASE A

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *a* | $X$ | $\times T$ | = 4.2 | × | 500 | = | 2,100 B.t.u. total sensible heat contained in dry gas |
| *b* | $Xm$ | $\times Tw$ | = 3.38 | × | 377 | = | 1,274 B.t.u. of uncontrollable heat hence an unavoidable loss |
| *c* | $a - b$ | | = 2,100 | — | 1,274 | = | 826 B.t.u. of controllable heat |
| *d* | $(X-Xm)\times Tw$ | | = 0.82 | × | 377 | = | 309 B.t.u. of controllable heat due to excess air alone |
| *e* | $(T-Tw) \times Xm$ | | = 123 | × | 3.38 | = | 416 B.t.u. of controllable heat due to excess temperature alone |
| *f* | $(X-Xm)\times (T-Tw)$ | | = 0.82 | × | 123 | = | 101 B.t.u. of controllable heat due to both excess air and excess temperature |
| *g* | $10,160 \times Y$ | | = 10,160 | × | 0.0212 | = | 215 B.t.u. loss of potential heat due to incomplete combustion |

quantitative relation to one another is obtained by representing them graphically as shown in Fig. 1. This is readily done by drawing a horizontal line $AB$ representing $T$ deg. temperature, 100 deg. to the inch; a perpendicular line $AD$ representing $X$ B.t.u., one B.t.u. to the inch, then $X \times \frac{T}{100}$ correctly represents B.t.u. in square inches. Thus if $AB$ is made 5 in. long and $AD = X$, 4.2 in. long, the area of the completed rectangle

TABLE II—ANALYSIS OF HEAT LOSSES, CASE B

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *a'* | $X$ | $\times T$ | = 6.6 | × | 575 | = | 3,795 B.t.u. total sensible heat contained in dry gas |
| *b'* | $Xm$ | $\times Tw$ | = 3.38 | × | 377 | = | 1,274 B.t.u. of uncontrollable heat hence an unsavable loss |
| *c'* | $a' - b$ | | = 3,975 | — | 1,274 | = | 2,521 B.t.u. of controllable heat |
| *d'* | $(X-Xm) \times Tw$ | | = 3.38 | × | 377 | = | 1,214 B.t.u. of controllable heat due to excess air alone |
| *e'* | $(T-Tw) \times Xm$ | | = 198 | × | 3.38 | = | 669 B.t.u. of controllable heat due to excess temperature alone |
| *f'* | $(X-Xm) \times (T-Tw)$ | | = 3.22 | × | 198 | = | 667 B.t.u. of controllable heat due to both excess air and excess temperature |
| *g'* | $10,160 \times Y$ | | = 10,160 | × | 0.0162 | = | 164 B.t.u. loss of potential heat due to incomplete combustion |

$ABCD$ will represent the total heat in the dry gas of Case A, because $AC \times AB \times 100 = X \times T =$ B.t.u. total sensible heat contained in the dry gas.

In the same way, if $AE$ equals $X_m$ and $AG$ equals $\frac{T_w}{100}$, then the rectangle $AGFE$ will correctly represent component *b*, $X_m \times T_w$ the uncontrollable heat, and rectangle $EFID$ represents component *d*, $GBHF$ represents component *e*, and $FHCI$ component *f*. If the temperature $T$ were reduced to $T_w$, the line $BC$ would coincide with $GI$ and components *e* and *f* would be reduced to zero, but component *d* would not be affected, illustrating that component *d* represented by the rectangle $EFID$ is not affected by excess temperature and is due to excess air alone. If the per cent of excess air were reduced to zero, the $CO_2$ would be increased to $MCO_2$, which would reduce $X$ to $X_m$, causing the line $DC$ to coincide with the line $EH$, thus reducing components *d* and *f* to zero, but component *e* would not be affected, showing that it is due to excess temperature alone. Since component *f* is affected by both $X$ and $T$, it is chargeable to either or both excess air and temperature.

The object of analyzing the heat carried to waste up the chimney is, first, to determine how much of this heat is theoretically savable, and second, to ascertain the cause and locate the responsibility for the savable heat wasted. It has been clearly shown that $X - X_m$ and $T - T_w$ are the two principal control factors. The former is controlled by regulating the air supply and fire-bed for which the fireman alone is responsible, and the latter by keeping the boiler clean and the setting in repair for which the boiler cleaners are responsible. Heat loss component *g* due to CO represents a loss for which the fireman is also responsible. The heat loss due to CO is also graphically represented by dividing this loss by $T$ and extending the lines $AD$ and $BC$, $\frac{215}{500} = 0.43$ in., respectively to $K$ and $L$ and drawing the line $KL$. The rectangle

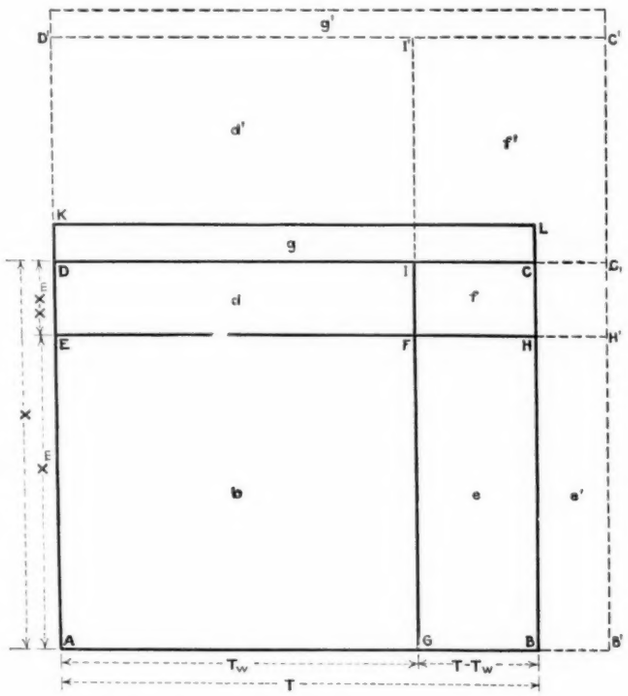



*Fig. 1—Graphical analysis of heat components in dry flue gas*

$DCLK$ thus formed correctly represents the heat loss component *g* due to *CO* in Case A.

It is evident, then, that the fireman is alone responsible for the heat loss $(X - X_m) \times T_w$, represented by component *d*. Also that the boiler cleaner is alone responsible for the heat loss $(T - T_w) \times X_m$, represented by component *e*. Because the heat loss $(X - X_m) \times (T - T_w)$, represented by component *f*, is affected by both excess air and temperature, it would seem proper that firemen and boiler cleaners should be held equally responsible for this loss. However, since an increase in excess air increases the temperature $T$ and thereby increases the loss of savable heat, it seems only fair that the firemen should be held responsible for both components *d* and *f*. Let us assume the increase in temperature due to an increase in excess air to be one degree per one per cent of increase in excess air. Thus, since the excess air was 75 per cent higher in Case B than in

Case A, the temperature $T$ was increased 75 deg. The heat loss components for Case B with 9.2 per cent $CO_2$ are as given in Table II and illustrated in Fig. 1 by the dotted lines. Since the increase in heat of Case A over Case B is due to excess air alone, the boiler cleaner,

TABLE III—COMPARISON OF HEAT LOSSES

| Heat Loss Components | Case A | Case B |
|---|---|---|
| $a$ | 2,100 | 3,795 |
| $b$ | 1,274 | 1,274 |
| $c$ | 826 | 2,521 |
| $d$ | 309 | 1,214 |
| $e$ | 416 | 669 |
| $f$ | 101 | 667 |
| $g$ | 215 | 164 |
| Total controllable (theoretically savable) heat in dry gas | | |
| $d+e+f+g$ | 1,041 | 2,714 |
| Fireman is responsible for components | | |
| $d+f+g$ | 625 | 2,045 |
| Boiler cleaner is responsible for component | | |
| $e$ | 416 | 669 |

responsible for component $c$, is wrongfully charged with $669 - 416 = 253$ B.t.u., represented in the diagram by the area $BB'H'H$. On the other hand, if the increase in temperature $T$ had been due to dirty boilers alone, the

TABLE IV—HEAT LOSS FACTORS FOR VARIOUS FUELS

| | COe | $X$ | $Xm$ | $X-Xm$ | $T$ | $Tw$ | $Y$ | Ht |
|---|---|---|---|---|---|---|---|---|
| Carbon | 16.8 | 3.72 | 3.02 | 0.70 | 500 | 388 | 0.00 | 0.00 |
| Anthracite | 15.7 | 3.96 | 3.22 | 0.74 | 500 | 388 | 0.019 | 0.032 |
| Bituminous | 14.8 | 4.19 | 3.38 | 0.81 | 500 | 388 | 0.020 | 0.066 |
| Fuel oil | 12.4 | 4.96 | 3.97 | 0.99 | 500 | 388 | 0.024 | 0.140 |
| Natural gas | 9.5 | 6.40 | 4.96 | 1.44 | 500 | 388 | 0.030 | 0.306 |

fireman would be wrongfully charged with half of component $f$ + the heat represented by the area $HH'C'C$. This overlapping of responsibility will tend to equalize in the long run and become insignificant in practice.

TABLE V—FORMULAS FOR DETERMINING HEAT COMPONENTS

$a = X \times T$ = B.t.u. total sensible heat in dry gas
$b = Xm \times Tw$ = B.t.u. uncontrollable heat
$c = (X \times T) - (Tw \times Xm) = a - b$ = B.t.u. controllable heat
$d = (X - Xm) \times Tw$ = B.t.u. controllable heat loss due to excess air
$e = Xm \times (T - Tw)$ = B.t.u. controllable heat loss due to excess temperature
$f = (X - Xm) \times (T - Tw)$ = B.t.u. controllable heat loss due to both excess air and excess temperature
$g = Y \times 10{,}160$ = B.t.u. controllable potential heat in dry gas
$h = Ht\,[10{,}640 + 4.3 \times (T - 212)]$ = B.t.u. total heat in wet gas
$i = Ht \times 10{,}640$ = B.t.u. latent heat in wet gas
$j = Ht \times 4.3 \times (T - 212)$ = B.t.u. sensible heat in wet gas
$k = Ht \times 4.3 \times (Tw - 212)$ = B.t.u. uncontrollable sensible heat
$l = Ht \times 4.3\,(T - Tw)$ = B.t.u. controllable sensible heat
$m^* = \dfrac{a \times pc}{1 - pc} \times 14{,}600$ = B.t.u. controllable potential heat in ash
$n$ = B.t.u. uncontrollable heat loss due to radiation
*a = weight of ash in fuel per per cent unit
pc = per cent carbon in refuse.

It is important to note that component $B$ is independent of both excess air and excess temperature. It depends on the value of $X_m$, which is practically constant for each kind of fuel, and the temperature of the water

TABLE VI—COMPARISON OF HEAT LOSS COMPONENTS FOR VARIOUS FUELS

| Heat Loss Components | Carbon B.t.u. | Anthracite B.t.u. | Bituminous B.t.u. | Fuel Oil B.t.u. | Natural Gas B.t.u. |
|---|---|---|---|---|---|
| $a$ | 1,860 | 1,980 | 2,095 | 2,480 | 3,200 |
| $b$ | 1,172 | 1,249 | 1,311 | 1,540 | 1,924 |
| $c$ | 688 | 731 | 784 | 940 | 1,276 |
| $d$ | 272 | 287 | 314 | 384 | 559 |
| $e$ | 338 | 361 | 378 | 445 | 556 |
| $f$ | 78 | 83 | 91 | 111 | 161 |
| $g$ | 183 | 193 | 202 | 244 | 305 |
| $f$ | 00 | 380 | 753 | 1,663 | 3,634 |
| $i$ | 00 | 340 | 671 | 1,490 | 3,256 |
| $j$ | 00 | 40 | 82 | 173 | 379 |
| $k$ | 00 | 24 | 50 | 106 | 232 |
| $l$ | 00 | 16 | 32 | 67 | 147 |
| $m^*$ | 438 | 438 | 438 | 00 | 00 |
| $n$† | 292 | 326 | 358 | 462 | 680 |

* $a$, the weight of ash per per cent unit is assumed to be 0.12 lb. and pc W 20 per cent carbon in refuse.
† $n$ is assumed to be 2 per cent of the heat in fuel.

in the boiler $T_w$, which is practically constant in any given plant; thus $X_m \times T_w = b$ must also be practically constant. The great importance of this will appear farther on. Components $a$, $b$ and $c$ do not enter directly in the control of economic boiler operation. Components $d$ and $f$, $g$ and $e$ give all the information required for exercising complete control; that is, knowing to what the savable heat losses are due and holding the right person responsible.

The operating data required to enable the engineer to exercise complete control are $CO_2$, $CO$, $T$ and steam pressure, preferably all graphically recorded.

To make the heat loss analysis complete, it must, in addition to the dry gas loss components, also include the

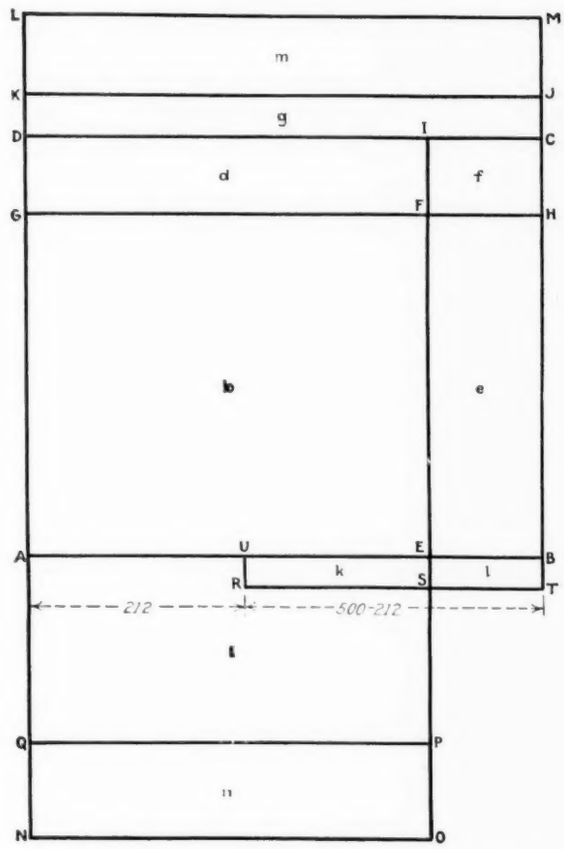



*Fig. 2—Graphical analysis of all heat-loss components*

water vapor loss components, the loss of potential heat (fuel) through the grate and the loss due to radiation.

The factors $X_m$ and $T_w$ determine the uncontrollable heat in the dry gas, and $H_t$ determines the heat in the water vapor, which is practically all uncontrollable. For each class of fuel $X_m$ and $H_t$ are practically constant and $T_w$ is practically constant in any given boiler plant. Thus all factors being constant, the results must also be constant from plant to plant. The values of $X_m$ and $H_t$ for the five principle fuels are as follows:

| | Carbon | Anthracite | Bituminous | Fuel Oil | Natural Ga. |
|---|---|---|---|---|---|
| Xm = | 3.02 | 3.22 | 3.38 | 3.97 | 4.82 |
| Ht = | 0.00 | 0.032 | 0.066 | 0.144 | 0.306 |

To make the results obtained from the different fuels comparable, let us assume that a given boiler was fired at successive intervals with the five classes of fuel; also that combustion was carried on with 25 per cent excess air, that $T = 500$ deg. and CO averaged 0.30 per cent, steam pressure 200 lb. From the respective formulas we find the heat loss factors to be as given in Table IV. Applying these factors in the analytical heat loss formulas as given in Table V, the heat loss components for each class of fuel are obtained and given in Table VI. This table gives a complete analysis of the heat losses of the four

principal fuels, also of carbon burned under the conditions assumed. Fig. 2 represents the analysis for bituminous coal diagrammatically. In this diagram, as in that shown on Fig. 1, the quantitative value of every heat loss component is represented by the area of a rectangle.

The construction of the diagram representing the heat loss components in the dry gas was previously explained. Since $AD$ is proportional to $X$ and $AB$ is proportional to $T$, $AD \times AB$ must be proportional to $X \times T$. Since $X \times T = 2{,}095$ and $T = 500$, we have $X \times 500 = AD \times 500 = 2{,}095$, hence $AD = \frac{2{,}095}{500} = 4.19$ units of length $= X$.

Thus if we know the length of the horizontal sides of a rectangle and its area, we know the length of the other two sides. Then, since $DC = 500$ and component $g = 204$ B.t.u., we have $\frac{204}{500} = 0.41$ unit of length $= DK$. In the same way, since component $m = 438$ B.t.u., we have $\frac{438}{500} = 0.88$ unit of length $= KL$. Thus the areas $DCJK$ and $KJML$ represent components $m$ and $g$. Similarly, we find the areas that represent the unavailable heat loss components $i$, $k$ and $n$. In this case $QP = T_w = 388$, and since components $i + k = 721$ B.t.u., we have $\frac{721}{388} = 1.83$ units of length $= AQ$, and since component $n = 358$ B.t.u., we have $\frac{358}{388} = 0.92$ unit of length $= QN$, hence the areas $QPEA$ and $NOPQ$ represent the components $i$, $k$ and $n$. The heat loss components $k + l = j = 82$ B.t.u. of sensible heat in the water vapor. The line $RT$ represents $T - 212 = 500 - 212 = 288$ deg.; hence, since $j = 82$ B.t.u., we have $\frac{82}{288} = 0.29$ unit of length $= RU$. Therefore, the area $RTBU$ represents component $j$. Component $j$ consists of two parts $k$ and $l$, of which the latter is controllable by $T$ as the diagram plainly shows.

Thus the heat loss diagram clearly visualized the quantitative relation between the heat loss components. It groups them according to cause and responsibility. Components $d$, $f$, $m$ and $g$, represented by the rectangle $GHML$, are chargeable to combustion efficiency for which the firemen are responsible, and components $e$ and $l$, represented by the rectangle $STHF$, are chargeable to absorbtion efficiency for which the boiler cleaners are responsible. All the foregoing heat loss components are controllable and theoretically completely savable, because complete combustion without excess air would reduce components $d$, $f$, $m$ and $g$ to zero, and if the gas left the boiler at the temperature $T_w$, components $e$ and $l$ would be eliminated.

Components $b$, $i$, $k$ and $n$, represented by the rectangle $NOFG$, are unavailable to the boiler. And because this heat is unavailable to the boiler, it cannot be reduced by anything the operating personnel may do. Hence it is uncontrollable and therefore unsavable. The uncontrollable heat loss components are practically constant for a given class of fuel and operating conditions. On the other hand, the controllable heat loss components are quite variable.

# Modernization vs. Executive Resistance—III*

## The Engineer Is One Up

I GOT back from my vacation a few days ago and, believe me, I had a mighty fine time and got all pepped up, like I was training for one of these heavyweight fights. And I'll tell you I've got a fight on my hands and it's coming off mighty soon. After what I saw on my trip, if I don't make the old man take the count inside of a couple of rounds—well, you just wait!

What did I see? I took the wife off in the old bus for a tour all 'round the country, and by a lucky chance we happened to stop each day handy to some plant I wanted to investigate (yes, I planned the route myself), so while she rests up or goes shopping, I took the car 'round and got some real inside dope on what's going on in these new power plants, and say, boy, I can tell you things

*"I took the car 'round and got some real inside dope on what's going on in these new power plants"*

are sure moving some. I wanted to see some high-pressure utilities as well as all the new industrial plants I could, to see if there were any strings to these new ideas and I certainly had my eyes opened.

I knew things must be running pretty smoothly or there wouldn't be all these new high-pressure plants following one after the other, but I did think there would be more troubles than there seems to be. I asked the superintendent of one of the big central station plants if the men weren't a bit leery of the high pressures, and he said that the first day or two they were, but that after that the only difference they noticed was the pointers on the pressure gages went to a different mark. Then I thought there would be a good deal of trouble with steam joints, but he told me that in nine months they had been operating they had only had one leak on the whole system and that was through a pinhole in a steel casting. He had all his piping with welded flanges end to end of the entire job, and I certainly like that idea. Still, at that, there were lots of gaskets on valve covers and other odd places, and they didn't seem to give any trouble.

Then I saw some fine pulverized fuel installations, some with water walls and some without, and when it

*The third article of a series providing a sequel to an article which appeared in *Power* of May 10 last under the title, "Why I Am Not Going to Modernize My Plant."

comes to choosing my plant, I'll have something to say along those lines. No fires to get clinkered up or to burn down for cleaning and no brick walls to replace just the very time you can't spare the boiler. The more you can cut out all sources of possible trouble, the happier you are likely to be. That's why I like these all black furnace walls too. If you're going to start cutting out refractories by putting in water walls, why not make a job of it?

Well, I saw all these fine new utility plants right up to the minute with all possible improvements, with their boilers giving 85 per cent efficiency or more, their 400-deg. preheated air, their regenerative cycles, their reheaters for steam from the high-pressure cylinders to bring it back to 700-deg. temperature, and their fine engineering staffs, and then I looked at the discharge from their condensers and I thought, "For all your splendid equipment and for all your making a kilowatt-hour for less than a pound of coal, there flows away invisibly, to total waste, 1,500 lb. out of every ton of coal you buy."

And then I'd get back into my flivver and go and see one of these real up-to-date industrial plants (like I'm going to have myself pretty soon) and find them making use of all this waste heat on their process work and getting their power for maybe a half of what it cost the public utility to make it in a plant a hundred times the size, and for about an eighth of what they could buy it for, and I tell you it made me feel I was going back home with something to say.

Well, I went back and said it and didn't waste any time over it either. I saw Mr. Bliman the day after I got home and found him in a pretty good mood on the whole, though I hear orders aren't coming in any too well, and I've a hunch about who's getting them. You know the Ideal Mills started up their new power plant about six weeks ago, and I hear their production is up 10 per cent, so I guess they are selling it somewhere.

I hate to see us losing business, but a little medicine at times does one a lot of good.

When I told the boss where I'd been on my vacation and what I'd seen, he says, "I thought you told me you wanted a vacation for your health, not for business." So I told him I figured it would do my health a lot of good if I could get a new power plant and get rid of the worry of trying to keep up our old pile of junk. He flared up at that and wanted to know whose fault it was if it was a pile of junk. "Well," I says, "The old plant's been working day and night for the last twelve years, so I think it's earned the right to be a pile of junk if it wants.

"It's not that it's in such terrible shape either, but even if it was as good as new, it would still be a pile of junk in comparison with what one can buy nowadays. People aren't satisfied with hand firing, lots of labor and 50 per cent efficiency these times, and that's what we've got to wake up to."

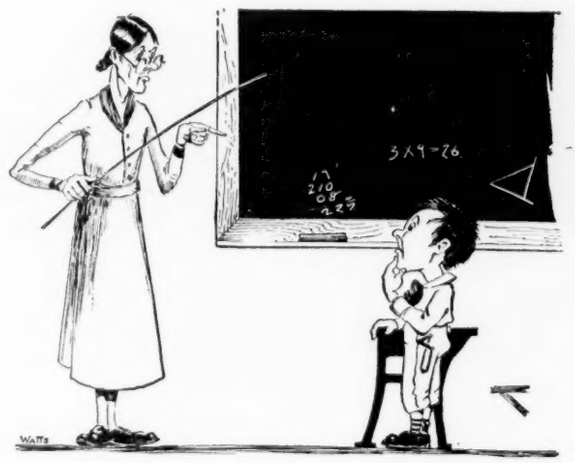
I told you I was full of pep, Bill, and ready for a fight, but he took it mighty quiet and allowed he'd been thinking things over while I was away. That was about the most encouraging remark I'd heard from him since my dogs were pups. I got all excited and asked him when we would start. "Hold on," he says, "You've got me all wrong. I said I'd been thinking about it, but that don't say I've changed my mind. You've got to show me and show me good before you'll convince me.

"Don't forget it's my money that would take all the risk, not yours, and a man's likely to be mighty tender when he thinks of the health of his own pocket. If it hadn't been for that darn mill over there playing their fool tricks and underselling me instead of leaving things go along as they were, I wouldn't be listening to you now. As it is, I suppose if they can make a good thing out of it we can; that is, if the whole trouble really is due to any savings they are making and not just a case of price cutting.

"I guess I might slip away next week and see one or two of those new mills you were telling me about. I'm all for scientific investigation, as you know, Jim, and I believe in being up to date if it don't cost anything."

Well this all looks very encouraging to me, Bill, so I give him the straight dope a bit longer and told him where he could see some of these high-pressure plants, and then I let on I was some pleased he was changing his mind, but he wasn't standing for that. "Say, Jim," he says, "Do you play golf?" "Not now," I says, "But I hope I'll have time to play when we get our new plant going." "Well," he says, "If you played golf, I'd say that right now I'd be willing to admit you're one up, but there's many a game been lost by the man who was one up at the turn."

Never mind, Bill, I'd a heck of a sight rather be one up than one down, and mark my words, we'll see my new power plant yet.




# What Do You Know?

By L. H. Morrison

*The answers are on page 158*

Ques. 1—Why is more than 26 in. vacuum considered uneconomical for operation of a condensing engine?

Ques. 2—If the air is at the dew point and the dry-bulb temperature is 60 deg. F., what will be the wet-bulb temperature?

Ques. 3—If you had a non-condensing compound engine, how would you rebalance the load between the two cylinders in case the steam pressure was raised, without changing the cutoff of the low-pressure cylinder?

Ques. 4—In case you had a horizontal engine that set up vibrations of the foundations, would it be better to increase the bearing surface area of the foundation or its mass?

Ques. 5—In a certain plant it has been found that the boiler is called upon to generate more steam when heating the building by adding live steam to the exhaust of the engine operated with a light load than when there is a heavy load on the engine and plenty of exhaust for the heating without addition of live steam. What is the explanation?

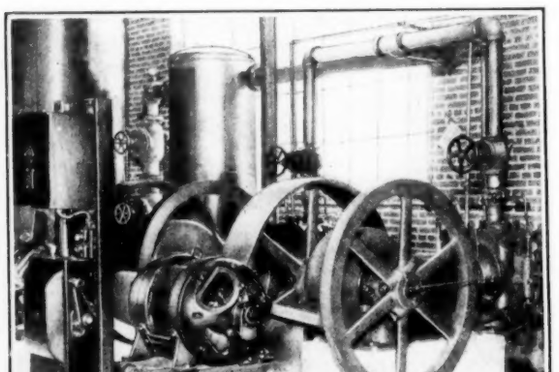
Ques. 6—Why is a hot-bulb oil engine more suited for a constant than a varying load?

Ques. 7—Can pulverized coal be transported a mile or more?

Ques. 8—Why is a two-stroke-cycle gas engine usually less economical with gas than is a four-stroke-cycle engine of the same mechanical efficiency?

Ques. 9—Which requires the more compression, a high-speed or a low-speed steam engine? The actual piston speeds of both engines are assumed to be the same, but the high speed has a high r.p.m., of say, 300 and the other engine runs at 100 r.p.m.; both have equally heavy reciprocating parts.

Ques. 10—What is wrong with the picture of two air compressors connected to a receiver?



*What is wrong with this picture which is referred to in Ques. 10*

IN THE COTTON TEXTILE INDUSTRY the cost of power averages only about 6 per cent of the total manufacturing cost of the finished product. However, when the size of the industry is considered and the basis changed from percentage to actual power units, this power consumption becomes important. There are in the world today about 162,000,000 spindles, of which 38,000,000 are in the United States. A fair average power estimate is 31 spindles to the indicated kilowatt, or a total of approximately 5,200,000 indicated kilowatts in the world and 1,200,000 indicated kilowatts in the United States. For yearly operation, the world consumption is over 15,000,000,000 kilowatt-hours.—*George Wrigley, in Mechanical Engineering.*

## The Steam Engine Applied to the Bus*

BY J. F. MILLER†

FOR the last year the Detroit Motorbus Company has had in operation a 61-passenger, double-deck, steam-driven bus. It has traveled more than 28,000 miles, and while it is still too early to draw conclusions, not only have the results to date demonstrated the possibilities of steam as a motive power in bus transportation, but the claim is made that a steam power plant will prove superior to the gasoline engine in city bus service.

This unit consists of a high-pressure flash-type boiler, a burner that handles gasoline or fuel oil equally well, a system of automatic controls that functions entirely independent of the driver, together with a four-cylinder cross-compound engine that develops 82.6 b.hp. at 820 r.p.m., with a water consumption rate of 11.13 lb. per horsepower-hour. A so-called auxiliary unit houses the boiler-feed pumps, vacuum pumps, lubricator and electric generator, all of which are driven off one end of the engine crankshaft. An exhaust-steam condenser takes the place of the ordinary bus radiator and permits the water to be used over again for steam-making purposes after passing through the engine.

The firebox is built of sheet nichrome steel and has a circular shell 24 in. in diameter and 18 in. high. A nozzle is provided for the injection of the air-fuel mixture into the combustion chamber. The air is obtained by a blower driven by a constant-speed electric motor, and fuel is metered through a specially designed carburetor. Ignition is by a magneto and a standard spark plug, no pilot light of any kind being used. Firing is entirely automatic and the burner always operates at full capacity. Flue gases pass along the outside of the boiler coils in a counter direction to the flow of water and steam inside. The boiler is of the single-tube type and is designed to deliver steam at a maximum pressure of 1,250 lb. and at 800 deg. F. total temperature. The weight complete, including burner, firebox, casing and accessories, is but 490 pounds.

The engine has two high-pressure pistons of $2\frac{5}{8}$-in. diameter and two low-pressure pistons of $4\frac{1}{2}$-in. diameter, each with a 5-in. stroke. Two piston valves control the steam to the cylinders, one valve serving one high- and one low-pressure cylinder. Valves are driven by a Stephenson link motion. For starting, steam is cut off at 85 per cent of the stroke, for accelerating at 65 per cent, and for normal running speed at 45 per cent. The engine in the redesigned unit is built integral with the front rear axle, there being two sets of rear wheels. A cartridge-core type condenser with $\frac{1}{4}$-in. tubes size 30x30 in., with a depth of 8 in., takes the place of the ordinary radiator. Exhaust steam enters at the top, is condensed and water is drawn off at the bottom. A 27-in. diameter belt-driven fan facilitates condensation.

The auxiliary unit houses the 300-watt Robert Bosch motor-generator, the four boiler feed pumps, the two vacuum pumps, the lubricator and provision for a fan drive. The motor-generator functions normally as a generator, but by throwing a switch it acts as a motor operated by a 12-volt battery to drive the water pumps. This enables the boiler to be filled without moving the engine.

*Abstract of article in *Bus Transportation*, January, 1928, issue.
†Engineer-in-charge, Detroit Motorbus Company.

# Long-Distance Transmission of Steam

By C. W. Conrad
*Plant Engineer, Bird & Son, Inc., East Walpole, Mass.*

TRANSMISSION of steam[1] for long distances is usually avoided and is generally considered uneconomical. However, the long steam line has a definite economic value in eliminating certain industrial wastes, and unquestionably it will come into more common use. The important utility of long-distance steam transmission is that it makes possible the centralization of steam generation.

During the fall of 1924 Bird & Son, Inc., operated two boiler plants situated a distance of approximately 4,000 ft. apart. The East Walpole plant, consisting of four 8,220-sq.ft. and two 3,350-sq.ft. Stirling boilers, equipped with underfeed stokers, furnished steam at 165 lb. pressure for the paper mill and for electric power generation. This boiler plant was of modern construction, as it had been rebuilt in 1921. The Norwood boiler plant furnished process steam at 110 lb. pressure for the roofing plant and for the floor covering plant, and had five water-tube boilers, with an aggregate of 13,000 sq.ft. Four of the boilers had low settings and were oil fired. The fifth boiler (heating surface 3,000 sq.ft.) was equipped with a Dutch oven furnace, hand stoker and oil burner. This boiler was an incinerator for disposing of roofing and floor covering waste materials, the oil burner being used for heating up the setting to permit smokeless combustion of the waste.

At the time stated the cost of fuel oil was rising rapidly. Charges for steam were mounting to unreasonable figures, and it was apparent that a radical change was necessary. It was decided to install the steam main, because it was the best business proposition. Owing to fixed charges, cost of ash disposal and increased labor expense, a new boiler plant could not generate steam at a much lower cost than the almost fully depreciated oil burning plant with the prevailing cost of oil. Furthermore, a suitable location for a new plant with its required coal storage was not available, and, perhaps most important of all, the investment required was much greater than was desirable to make at that time.

[1]Abstract of paper presented before the Boston Section, A.S.M.E., Oct. 26, 1927.

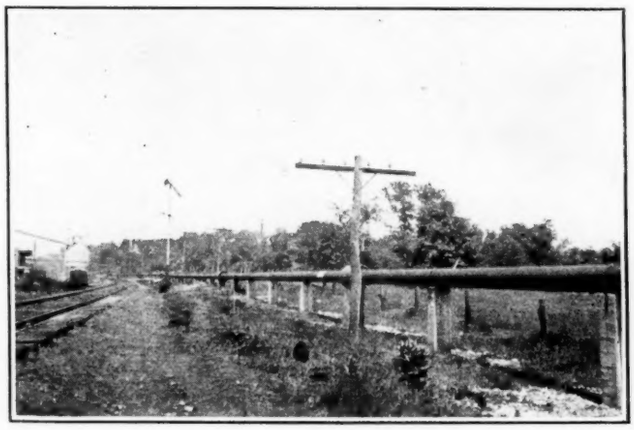


*Fig. 1—Long-distance steam main along railroad right-of-way*

*Fig. 2—Expansion bend in long-distance steam main*

Conditions were particularly advantageous for supplying steam from the East Walpole plant. Other than the steam line no additional equipment was required, as capacity was available by operating boilers at higher ratings. Unit cost of steam at East Walpole was two-thirds of the cost at the Norwood plant and would be further decreased owing to greater output. Operating expense at the Norwood plant could be greatly reduced and fuel cost practically eliminated.

The steam main was built, and since June 1, 1925, the East Walpole plant has furnished about 90 per cent of the steam required for process at the roofing and floor covering plants. The boiler equipped for burning waste at the Norwood plant could not be shut down, as there was no other satisfactory method of waste disposal. It is operated about six hours daily and generates the remaining 10 per cent of process steam required. The operation of this boiler is unnecessary as a source of steam supply, and as a steam generator it is a distinct liability.

## Description of Installation

The construction of this steam line can be summarized as follows:

(*a*) Length of line—4,550 ft.
(*b*) Equivalent length, allowing for resistance of fittings, etc.—4,839 ft.
(*c*) Size of pipe—8 in. diameter, 0.0322 in. thick steel pipe.
(*d*) Supports—Reinforced concrete piers, steel towers, Lally columns. Piers 20 ft. centers.
(*e*) Provisions for expansion—Bends and slip joints.
(*f*) Joints—Electrically welded and annealed, Van Stone joints at fittings, bends and slip joints.
(*g*) Drips—Eight in all, each equipped with two traps.
(*h*) Insulation—Two layers of 1½-in. magnesia, 3-in. in all, with two thicknesses of Paroid roofing sealed with roof coating.
(*i*) Fittings and valves—Extra heavy steel.
(*j*) Designed for 200 lb. pressure, 100 deg. F. superheat.

The main starts at the East Walpole boiler room header with a triple-duty valve, runs on the owners' property mainly through buildings for a distance of approximately 630 ft., thence under a public highway to the property of the N. Y., N. H. & H. R.R. It extends

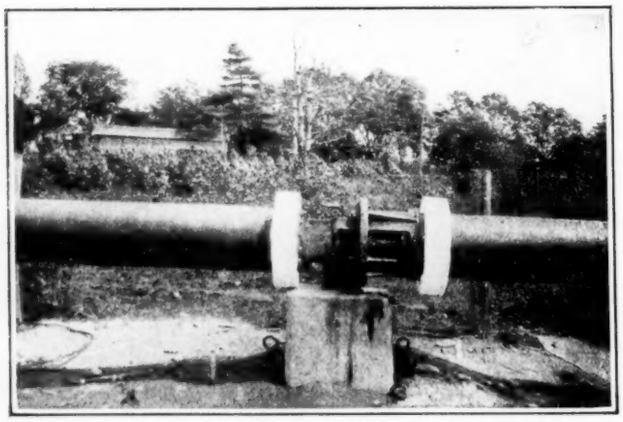


*Fig. 3—Slip-joint with insulation removed*

3,524 ft. on the right-of-way of this company at an average elevation of four feet above ground level, and then rises and is carried 30 ft. overhead on towers, 314 ft. on the owners' property into the Norwood boiler room. Here it connects into the boiler room header through a non-return valve and a reducing valve. Condensation is not returned, as the cost of pumping and fixed charges on equipment necessary do not equal the value of the heat in the condensation.

Although the steam main is designed for 200 lb. pressure and 100 deg. F. superheat, steam with these characteristics has not been available for supply. Owing to certain engine equipment in the paper mill not being suitable until recently for higher pressures, steam pressure in the boiler room has been limited to 165 lb. However, it is now 185-190 lb., with no superheat. The average steam flow in the line is 24,000 lb. an hour and a maximum hourly flow of 42,000 lb. has been observed.

Since June, 1925, steam has been off the line but three times. On Oct. 12, 1925, the main was taken out of service and the original packing furnished by the manufacturer for the expansion joints was replaced. On Feb. 3, 1926, pressure was off for one hour while holes were drilled for nozzles used for testing. On May 30 and 31, 1927, the steam line was out of service when a section of the East Walpole boiler room steam header was being replaced. At these times boiler equipment has been operated at the Norwood plant to supply steam for manufacturing. It is felt that this record shows satisfactory reliability, as only one shutdown can be charged to the line and this was caused by defective material that was immediately apparent when operation was started.

TABLE I—TEST ON STEAM MAIN

| | |
|---|---|
| Feb. 11, 1926, 8-hour test, average outdoor temperature 25 deg. F. | |
| Steam supply end | 163.3 lb. gage, quality 99.15 per cent |
| Steam delivery end | 133.0 lb. gage, quality 96.52 per cent |
| Average hourly flow | 31,204 lb. |
| Drop in pressure | 30.3 lb. |
| Loss due to condensation trapped off | 195,345 B.t.u. hourly |
| Loss due to latent heat of steam condensed | 791,779 B.t.u. hourly |
| Line loss at above flow | 2.69 per cent |

TABLE II—FIGURES FROM OTHER TESTS OF STEAM MAIN

| | |
|---|---|
| Flow | 14,000 per hour |
| Steam supply end | 183.3 lb. gage, quality 98.66 per cent |
| Steam delivery end | 180.9 lb. gage, quality 97.74 per cent |
| Drop in pressure | 2.4 lb. |
| Flow | 24,000 lb. per hour |
| Steam supply end | 181.0 lb. gage, quality 98.52 per cent |
| Steam delivery end | 165.3 lb. gage, quality 96.7 per cent |
| Drop in pressure | 15.7 lb. |

Tests have been made from time to time, and some data from these are given in Tables I and II.

The cost of the installation was $85,949.54. Results of operation show that from June 1, 1925, to Oct. 1, 1927, there was a net saving of approximately $73,000. This was determined by deducting actual cost of operation, including all fixed charges, from the total expense that would obtain with the Norwood plant in operation with fuel oil at market prices during this period. This represents a net annual return of 36 per cent on the investment.

### Comments on Long Steam Mains

The design of a long steam main offers no unusual problems. It deals chiefly with calculations of drop in pressure, change in quality or superheat, radiation losses and expansion. All these follow well-known laws, but formulas are empirical and final results will vary somewhat from calculated. In calculations for drop in pressure the formula given in Gebhardt's "Steam Power Plant Engineering," page 751, has been found to check closely with observed conditions using the constant credited to Babcock. As the density of steam varies with pressure and superheat, it is, of course, important that the proper value for this variable be used.

To predict the quality of steam or drop in superheat, it is convenient to use the entropy diagram. By starting with initial steam conditions and assuming constant entropy, the quality or degree superheat can be determined for the calculated or desired pressure at the end of the line and the corresponding heat drop can be obtained. In practice there will be lower quality or superheat due to entrained moisture from condensation due to radiation, and the accuracy of the prediction will depend on the efficacy of equipment to remove this moisture. The heat drop due to frictional drop in pressure does not constitute a loss, as it reappears and evaporates moisture. Whether there is an energy loss due to the drop depends on the equipment to which the steam is delivered and in which it is used.

The impression is general that radiation losses in a long steam line are high, but tests and calculations prove the contrary. One of the surest ways of dispelling this impression is to make loss calculations on a specific in-

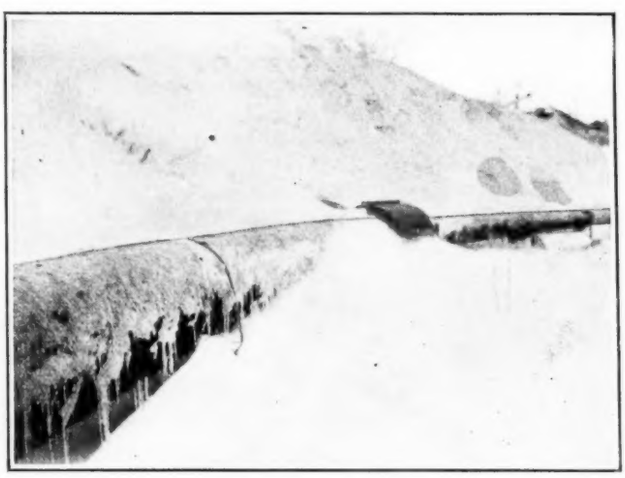


*Fig. 4—Snow and sleet on steam main, indicating low heat losses*

stallation using data based on scientific investigation. L. B. McMillan's "Heat Transfer Through Insulation in the Moderate and High Temperature Fields," Trans. A.S.M.E., Vol. 48, page 1296, is a comprehensive exposition on the subject of radiation losses. Here will be found formulas that permit the calculation of pipe radiation and the most economical thickness of insulation. Losses in practice with exposed mains will be affected by wind, rain, sleet, snow and heat from the sun's rays as well as temperature differences. With underground mains effectiveness of drainage of ground water must be considered.

Elongation due to temperature increase must be carefully worked out, bearing in mind that the coefficient of expansion of steel increases with temperature. Enormous forces exist and proper calculations for anchorage are of great importance.

The type of construction of a long steam main depends on the available right-of-way. The overhead main is to be preferred on account of its lower cost. The welded joint is essential and best practice requires that the weld be annealed.

Expansion must be taken care of by bends or slip joints. Although construction with the former is higher in first cost, they are generally preferred. The slip joint adequately fulfills its purpose and is readily installed. Thrust loads due to expansion must be properly anchored.

Entrained moisture due to condensation from radiation is difficult to remove with ordinary drip connections on account of the high velocity of flow. This naturally suggests the separator, which should be used with superheated as well as with saturated steam. The triple-duty valve is a safety feature that should be provided to shut off the supply in case of rupture.

### Limitations of Long Steam Mains

The limitations of distance of transmission are economic. Cost of installations, cost of steam, radiation losses, heat drop and requirements of pressure, quality or superheat are factors to be considered and, obviously, each project is an individual problem. One installation 2½ miles in length has been made. Another main 5,654 ft. long is designed for the transmission of 140,000 lb. of steam per hour with initial conditions of 250 lb. pressure and 200 deg. F. superheat. The line described in this article is 4,550 ft. to the center of distribution, and from this point steam is redistributed in other mains of an extreme length of 2,000 ft., thereby making the total distance 6,550 ft.

### Central Steam Generating Plants

Repeating the statement made previously, long-distance steam transmission permits centralization of steam generation. Advantages of the central steam plant have been much discussed—low unit cost, economical operation, superior supervision and reduction of smoke nuisance are some that are most apparent. Central heating plants are numerous. Hotels, office buildings, stores, apartments and residences are connected up with and are heated by them. The most important institutions of this type are parts of our public utility systems, many being the outgrowth of early central station practice of adding a low-pressure steam distribution system in order that the exhaust from non-condensing engines could be utilized. Few of the early installations were profitable because of the seasonal demand and apparent steam transmission losses. The long steam line thereby received a stigma that still stings. With the advent of the condensing plant many of these heating systems were reconstructed to use steam direct from boiler plants at medium pressures. Some utilities expanded their systems in business districts to promote power sales and, notwithstanding the fact that the load factor is generally low, most central heating plants have been quite profitable. In general it may be said that the central heating plant is economically sound.

The central steam generating plant for supplying manufacturing concerns with steam for process, heating, and possibly for power, has been proposed and there are some installations for this purpose. The idea is not readily accepted because the source of the supply has not been available, by reason of the general misconception regarding losses resulting with long-distance steam transmission, and because it has been customary to consider the boiler plant as an essential part of an industrial plant. However, under certain conditions the plan is as sound as central power generation, and there is as much justification for some industrial plants to purchase steam as to purchase power.

### Public Utility Operation of Central Steam Plants

The public utility is the logical operator of the central steam plant for supplying manufacturing concerns. The sale of steam under proper conditions would permit the central station to eliminate or greatly reduce their condenser losses. A kilowatt-hour on 13,000 B.t.u. is widely heralded, and it is stated that the 12,000-B.t.u. plant is in sight, but it is possible under ideal conditions where all exhaust could be sold, for the 6,000-B.t.u. plant to be a reality. It is true that the power generating equipment would be small. However, there are combinations of equipment using high pressure and superheat, and where appreciable quantities of steam could be sold, that would permit a fairly large plant to generate a kilowatt-hour on less than 10,000 B.t.u. Investment in plant and distribution would be high, but a large income from steam sales and appreciable reduction in power generating cost might justify it.

Projects of this kind will require thorough analysis, vision, high-class engineering and time to develop; however, the movement has started. Recently, a progressive utility, realizing the possibilities, offered to sell process steam to a manufacturer requiring about 100,000 lb. per hour at a price of $0.20 per 1,000 lb. The future may find our large utilities deeply interested in the development of a number of medium-sized combination power and steam supply plants suitably located to furnish manufacturers, or in establishing manufacturing districts around their base plants to obtain a market.

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When the Percentage of Feed Water Makeup is small, it is usually possible to find a source of heat around the power plant that will serve as a heat supply to the necessary evaporators. When the whole or nearly all of the boiler feed is makeup, it is generally impossible to furnish this from evaporators; hence more boilers must be installed to permit operation at the lower ratings necessary with such water. Plants operating under conditions between these two limits present serious problems in providing the necessary heat to evaporators.

# ELECTRICAL
## *Operation and Maintenance*

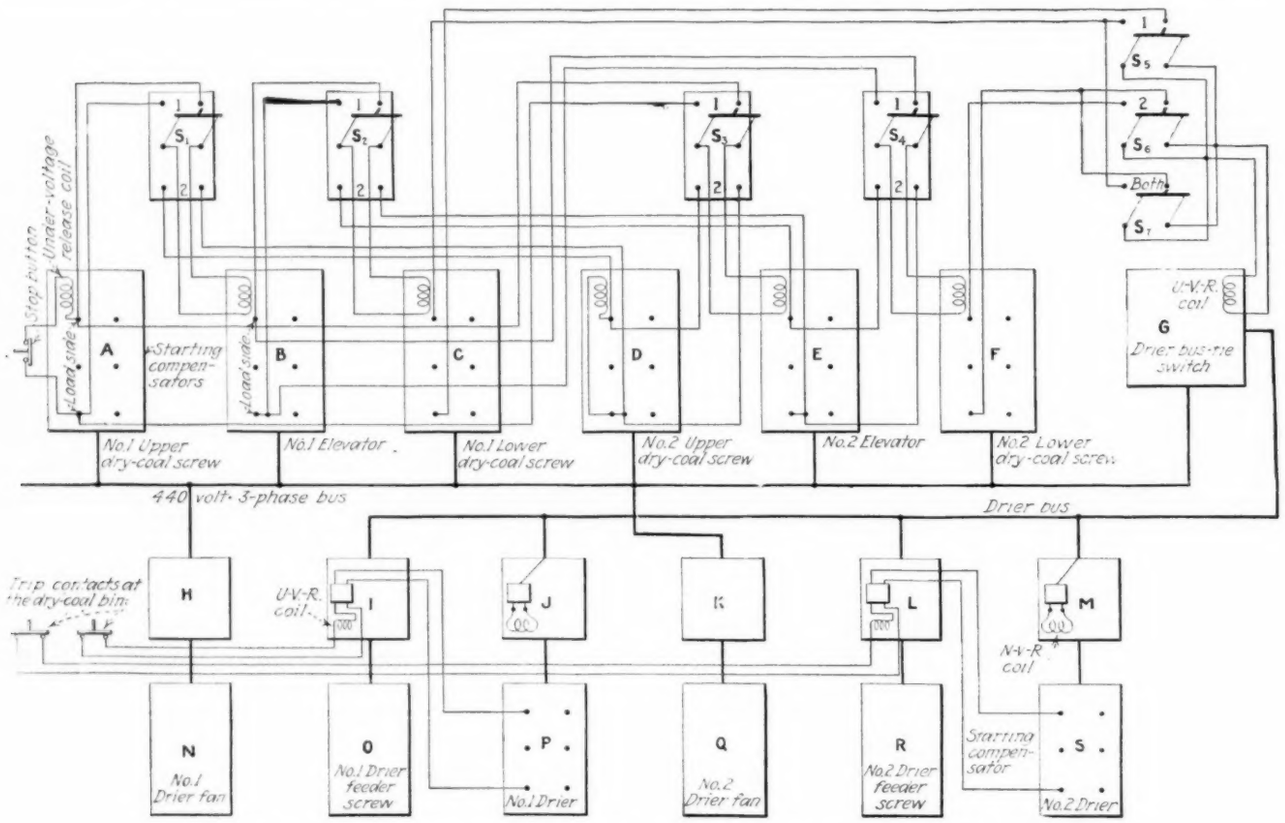


*Diagram of connection for interlocking the operations in a coal-drying system*

# *Electrical Interlock System for*
# Coal-Drying Plant Control

By RAY F. GOOD

IN OUR plant, originally, the coal-pulverizer system was designed to have two separate units for drying and handling the raw coal. In each unit a screw conveyor fed the coal into a drier. From there the coal was run over a scale and into a lower dry-coal screw that fed into an elevator. From the elevator the coal was delivered to an upper dry-coal screw that fed the coal to the different storage bins.

In the original layout the drier system was equipped with blinker signals on each operation to indicate to the operator when any part had stopped. It required considerable attention to keep this signal system in operation, and it was abandoned. In place of the signals the various operations in preparing the coal were interlocked, so that each had to be performed in its proper sequence and if any one operation stopped, the others stopped automatically.

The new arrangement had the objection that any mechanical or electrical defect put the whole system out of service until the repair was made. This made it necessary to make changes to give a more flexible system. Mechanical arrangements were made to feed the output from either lower dry-coal screw to either elevator and from these elevators to either upper dry-coal screw and to either storage bin.

These operations were interlocked electrically by the use of switches which, when closed, energize the under-voltage release coils on the compensators. These coils

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are energized from the load side of the compensators, as indicated in the figure. It was found necessary to have three switches on the undervoltage release coil of the drier bus-tie switch $G$, so that this coil could be energized when either one or both of the lower dry-coal screws was running. Only one of these switches is closed at a time —$S_5$ when No. 1 unit is in operation, $S_6$ for No. 2 unit, and $S_7$ for Nos. 1 and 2 units. Switch $S_7$ is connected to the two units in such a way that should any part of either unit stop the drier bus-tie switch will be tripped out and the drier system stopped.

To prevent a short-circuit should more than one switch be closed in the group $S_5$, $S_6$ and $S_7$, the connections were phased out. By checking up the connections, it will be found that all three switches may be closed and not cause a short circuit.

### Preventing the Coal-Handling System Being Stopped When Loaded

After the system was put into operation, it was found that if the upper dry-coal screw motors tripped off from an overload caused by the bins becoming full, the whole system was left loaded for starting again. To overcome this objection, trips were placed in the dry bins to open contacts in the undervoltage release coils of the drier-feeder starting compensators. These trips stopped the drier feeders before the bins were full and allowed the system to run clear. Then if the system is shut down, all parts can be started under light load.

Assume that No. 1 unit is being started. First the furnace is fired, and then the drier fan is started. When the furnace is at a proper temperature, No. 1 upper dry-coal screw is started by compensator $A$. When this compensator has been close to the running side, its undervoltage release coil is energized, which allows the compensator to remain closed. Also, the upper contacts of switches $S_1$ and $S_3$ are made alive. This allows starting either No. 1 or No. 2 elevator.

Closing switch $S_1$ to the up position energizes the undervoltage release coil on starting compensator $B$, of elevator No. 1, which is next started. When this compensator is closed to the running position, the upper contacts on switch $S_2$ are made alive. Closing this switch to the up position energizes the no-voltage release coil on starting compensator $C$ for No. 1 lower dry-coal screw. When the starting compensator on this screw is closed to the running position, the top contacts on switch $S_5$ are connected to power.

When switch $S_5$ is closed, the undervoltage release coil on the drier bus-tie switch is made alive. The switch can now be closed and will remain closed. This operation will allow starting No. 1 drier by closing switch $J$ and compensator $P$. When No. 1 drier compensator is in the running position, the undervoltage release coil on switch $I$ is energized through the trip contacts in the dry-coal bins. Making the undervoltage release coil alive on switch $I$, holds this switch closed and permits starting No. 1 drier feeder screw.

The latter action puts the drier unit in operation. When the dry-coal bins are about seven-eighths filled, the trip contacts are opened and break the circuit through the undervoltage release coil on switch $I$. This switch opens and stops No. 1 drier feed screw and allows the system to empty into the dry-coal bins. When the ammeters on the motors are seen to indicate light load, thus showing that the system has cleared, the attendant pushes a stop button in the undervoltage release-coil circuit on the upper dry-screw starting compensator and this screw is stopped. When this compensator opens, it trips out $B$, and $B$ opening trips out $C$, which in turn trips the bus-tie switch $G$. The latter kills the power circuit to the drier and it is shut down.

Although only the system for No. 1 unit has been explained, No. 2 is the same as No. 1. Also, any combination of No. 1 and No. 2 systems may be operated and obtain the same interlocking as for No. 1, likewise for the two systems operating together.

## Phase-Balance Relays Protect Polyphase Motors

By E. H. Stivender

THE same protective relay systems may be applied to alternating-current motors as are used on alternating-current generators. Essential motors such as those for exciter motor-generator sets, boiler-feed pumps and condenser circulating-water pumps, are often protected by relays, which will open the circuit breaker only when conditions other than overloads in the driven machinery arise. This practice, which has become general in modern installations, as it permits the auxiliaries to sustain heavy overloads in emergencies, has resulted in the development of a number of different types of protective relays intended for use with polyphase motors and synchronous converters.

Types of relays for use primarily with alternating-current motors are: Undervoltage, reverse-power, reverse-phase and phase-balance relays. The phase-balance relay, discussed here, represents one of the latest types of protective relays and is coming into general use for the protection of important auxiliaries in power plants and other installations where continuity of service is essential.

Fig. 1 is a diagram of the induction time element of a General Electric phase-balance relay. Its principal element consists of six U-magnets $A$, $B$, $C$, $D$, $E$ and $F$, the coils of which are energized by current transformers in the three lines of a motor feeder. The magnets are arranged in pairs and act on three disks which operate contacts closing the circuit-breaker trip circuit. Pole-face shading coils of the magnets produce a rotating field tending to turn the disks, but owing to the location of the shading coils with respect to the pole faces, the torques of each magnet in a pair, act in opposing directions. As long as the currents in all phases are equal, the currents in all actuating coils will be equal, hence the disks will not move until the line currents become unbalanced. This characteristic permits any degree of balanced load to be placed on the motor with no tendency to open the

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circuit breaker. An overload relay *O* is placed in the circuit for cases where it is desired that the motor be disconnected at a certain value of balanced overload.

In this phase-balance relay the coils tending to hold the contacts open have 25 per cent more turns than those tending to close the contacts, so that the relay will not operate unless one phase carries over 25 per cent more current than the other phases. This effect can be altered to a small degree by changing the positions of the shading coils, which are adjustable. The contacts are operated through reduction gears, and a spring holds them open when the relay is de-energized. Time adjustments are accomplished by changing the position of the disk stop, thereby altering the distance between the contacts. As in all induction time-element instruments, permanent magnets serve to retard the rotation of the disks.

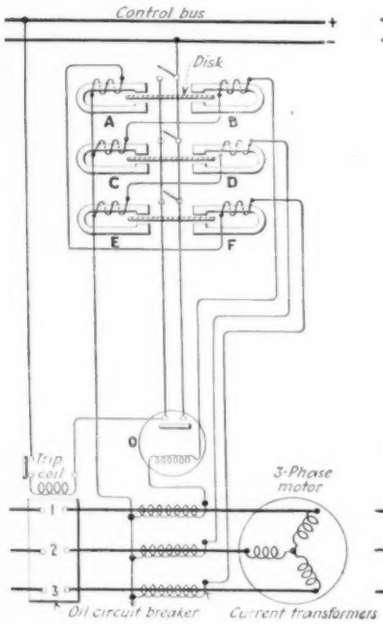



*Fig. 1 — Balanced relay protection using three current transformers*

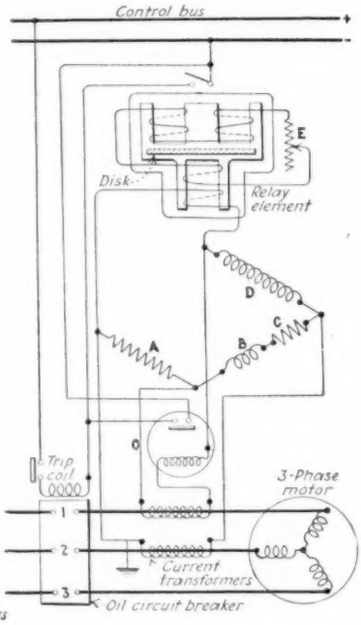



*Fig. 2 — Balanced relay protection using two current transformers*

### Reactor and Resistor Type

Fig. 2 is a diagram of a Westinghouse Company phase-balance relay, consisting of a combination of calibrated reactors and resistors so connected as to produce balanced forces across a modified time-element induction relay, when the proper phase rotation and balance exist in the motor feeder. *A* and *C* are resistors, while *B* and *D* are reactors. This system depends on the actions of instantaneous values of polyphase alternating current and when the effective values of these currents are equal, no current will flow through the relay element. The degree of unbalance necessary to operate the relay is determined by changing the impedance of the relay circuit. This is done by varying the value of resistor *E*. Time adjustments are the same as in induction overload relays. Only two current transformers are required for complete reverse phase and phase unbalance protection. Where balanced overload protection is required, a separate overload relay may be connected as at *O*.

An older type of Westinghouse phase-balance relay is composed of four relay elements, similar to that in Fig. 2, which operate in pairs on two disks. The four elements are controlled by three current transformers in the motor feeder and connected so that equal opposing torques are produced on the disks when a balanced load exists in the motor feeder. When a short-circuit or ground occurs in the motor, the differential action is destroyed and the relay operates to open the circuit breaker. This relay also protects against reverse phase without the use of additional relays.

Although the system of Fig. 2 possesses an economic advantage in requiring only two current transformers, it possesses the disadvantage of not permitting a common secondary ground at the transformers, which sacrifices safety of operation to a certain degree. However, where it is considered necessary to have this protection, a low-resistance spark gap is sometimes provided at the transformer in order that should primary voltage be imposed on the secondary side, its effects may be neutralized through the gap to ground.

It is necessary to provide undervoltage relays on motors driving loads that are likely to feed back power to the motor when an appreciable decrease in voltage occurs. This is especially the case where condenser circulating pump motors are operated without overload relays, for the head of water in the condenser may be sufficient to cause the pump to reverse, bringing an overload in the motor circuit, but owing to this load being balanced will not operate phase-balance relays.

The familiar system of differential relay protection can also be used for the purpose that Fig. 1 or 2 accomplishes, but this requires that the six leads of the motor winding be brought out for the installation of six current transformers. The system also requires three single-phase relays.

## Grounding Motors Neutral Causes Telephone Trouble

By Maurice D. Smith

SOME TIME ago several subscribers of a telephone company reported that they were receiving considerable noise over their telephones and that it was almost impossible to use them part of the time. The telephone company engineers investigated and found that the ground on the telephones was carrying a foreign current. Tests indicated that the current was from an alternating-current source and was not caused by any telephone equipment which employed only direct current for its power. The telephone engineers felt that the current was from the lines of an electric light and power company, whose engineers started an investigation.

The electric light and power company maintained in

# ELECTRICAL *Operation and Maintenance*

the vicinity a three-phase four-wire 2,300- and 4,000-volt feeder supplied from a star-connected bank of transformers. This feeder supplied current to a large 4,000-volt motor on a dredge. The power company's lines terminated at the shore line. A three-wire three-phase line had been extended by the dredge company from the shore to the dredge, which was approximately one-half mile out in the bay. These three-phase wires were connected to a set of switches for operating the motor, which had its winding connected star with the neutral connection brought outside the motor.

It was found that the electrician who connected the motor had apparently conceived the idea that he could save the neutral wire from the shore to the dredge by using the salt water as a conductor. He apparently also figured that the currents in a star-connected three-phase motor should be balanced and that it would cause little trouble. The motor's neutral wire was thus thrown overboard and the motor operated satisfactorily. As it happened, the phase currents tended to shift from time to time, thus causing current to flow from the motor neutral through the water back to shore and was picked up on the electric ground connections in the vicinity. These currents caused the telephone interference.

When the motor neutral was removed from the water, an arc was drawn, which showed current to be flowing in this part of the circuit. As soon as this was done, the telephone interference was eliminated. The motor was allowed to operate without a neutral connection, and it functioned satisfactorily. The ground connection was not necessary on the motor and probably resulted from arranging the windings so that a balanced-phase relay protection could be used if it were desired.

## Clock Used to Give Plant Signals

By James F. Hobart

IN a factory where it was required to ring electric bells each hour, on the hour, the engineer arranged the clock in the engine room to do this automatically. This clock was of the hour striking variety, which simplified the problem. The first thing done was to clean the clock and put it into good working order. It was also inclosed in a dustproof case and placed where it would be subjected to as small a variation of temperature as possible. All this was done to obtain as accurate time as could be expected under the conditions.

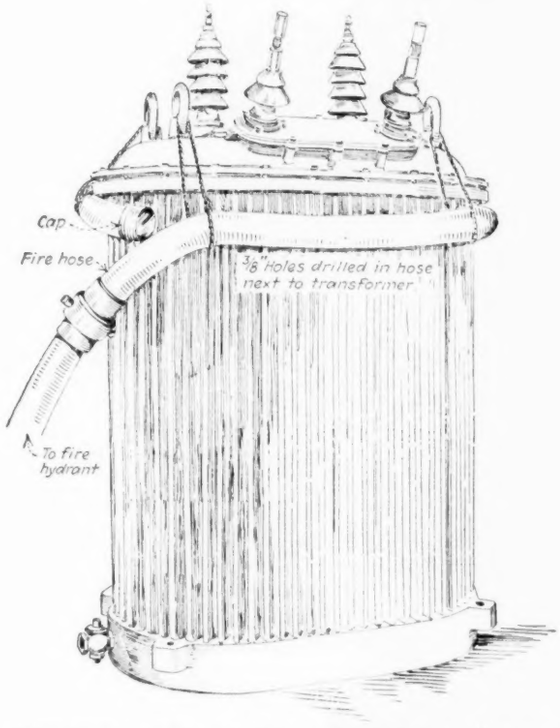
In the clock the gong was a spiral of spring wire. This was mounted on a Bakelite base to insulate it from the rest of the clockwork. Where the hammer struck the gong, a small piece of platinum was soldered and a similar piece on the face of the hammer, as it was intended to complete the electric circuit to ring the single-stroke signal bells through the gong and the clockwork. By using platinum where the circuit was to be made and broken, there would be no danger of the contact's oxidizing and not completing the circuit.

A wire was soldered to the gong support and was brought to a binding post on the outside of the clock. A wire was also connected to the frame of the clockwork and to a second binding post. To these binding posts the bells' circuit was connected. The bells were of the single-stroke type and would strike in unison with the clock. To slow up the rate of striking by the clock and give the bells time to function, the air damper on one of the clock's striking train-shaft was loaded. This allowed sufficient time between each stroke of the clock to permit the bells to complete their stroke cycle.

## Emergency Cooling of Transformers

By H. C. Klingenschmitt

IN A BANK of three single-phase transformers one suddenly failed. They had been connected delta-delta, so this one was quickly cut out. These transformers had been operating at about 125 per cent normal load. Naturally, the remaining two began to get very hot, the oil temperature reaching 90 deg. C. in a short time. However, several days must elapse before suitable replacements could be secured, and the busy cotton mill could not think of a curtailment without complaint.




*Fire-hose sprayer cools overloaded transformers*

A fire hydrant and several lengths of fire hose were available. A scrap length of old hose was salvaged from the junk pile. Along the entire length of the scrap piece $\frac{3}{8}$-in. holes were drilled through one side. This hose was tied around the tops of the transformers by looping wire through the eyebolts, with the holes facing the transformers, as indicated in the figure. When the water was turned on, an excellent spray all around the sides of the transformers resulted, and the oil temperature was soon brought down to about 50 deg. The transformers carried the load nicely with this arrangement.

# REFRIGERATION
## *Equipment and Operation*

# Automatic Ammonia Control Valves*

By H. C. VENEMANN

**A discussion of the shortcomings of existing automatic control valves and an outline of plant conditions that influence the operation of such expansion valves.**

IN THE short space of one generation we have seen mechanical refrigeration spread beyond the range of the centralized cold-storage and ice-plant operation, into the field of small automatically operated plants for meat markets, produce merchants, hotels, ice cream makers, dairies, etc., and of late years into our very homes. Today, large plants are adopting automatic labor saving equipment of various kinds to eliminate the careful and constant attention of the operating engineer, leaving him more time to devote to other things.

A fully automatic plant must have some device properly protected for starting and stopping the prime mover, another for controlling the feed of liquid ammonia and a third for regulating the supply of condensing water. The starting and stopping equipment is usually of an electrical nature, applied to motors only, and while more or less complicated, it is being made to function with a high degree of regularity and certainty. Its action may be controlled by temperatures in the rooms or brine tanks, or by pressures in any part of the system.

The regulation of the condensing water, while at present rather crude, is likewise being accomplished quite satisfactorily by diaphragm or sylphon valves actuated by either the condensing pressure or the temperature of water leaving the condenser. There is opportunity for considerable improvement in automatic water-control valves, in spite of the claims of various manufacturers.

The automatic control of the ammonia into the evaporators, while apparently a simple duty, is actually the most complicated of the three, because of the many additional variable conditions affecting its proper operation to which the other two devices are not subjected. For example, the automatic control of the ammonia, in addition to responding to pressure and temperature changes and the starting and stopping action of the compressors, is influenced by changes in loads, by the number of valves in the system, by the design of the evaporators as well as by their arrangement in the plant, by the number and sizes of compressors, and by the ranges of temperatures required.

Let us study for a moment some of these conditions, and we will appreciate better why no automatic valve can be made that will function properly under all of them. The condensing pressure, which is the pressure behind the liquid forcing it through the valve orifice, may in practice be at any point between 80 and 250 lb., while the suction pressure in the evaporator restricting the flow may vary between 0 and 45 lb. Since the velocity of flow is proportional to the square root of the pressure head, we can see that a change in either the discharge or suction pressures has a great influence on the quantity of liquid that will pass through the valve.

An operating engineer would ordinarily shut off the liquid supply just before shutting down his compressor, in order to prevent draining his receiver and building up an abnormal pressure in his evaporators. He would also open it again after starting his compressor. The automatic control valve must do likewise if it is to function without the aid of an operator.

Since the sole function of the control valve is to replenish an amount of liquid equal to that evaporated, it is quite evident that load changes must be considered when designing and applying automatic control valves.

Every operating engineer knows that the closing or opening of one important valve in the liquid line increases or retards the flow through all the others. He knows also that he cannot control the temperatures in several rooms unless each room is separately valved. In other words, each room must have its own control valve if connected in multiple, or be provided with by-passes if connected in series.

The number and capacities of the compressors that may be installed in the plant and the various combinations that may be made to put them into and cut them out of service to secure desired results economically, will affect the use of automatic control valves just as they affect the use of manual control valves in the average refrigerating plant.

All varieties of temperatures from —20 to +20 deg. F. are not uncommon in large plants, and these must be properly controlled. In some instances less than one degree fluctuation throughout a six-months' period is permissible.

When manual controlled valves are used, the operator depends upon external evidence to guide him. He cannot look into the evaporators to see whether he has opened the valve too much or too little. Many plants have only pressure gages to govern him, and the operator

*Paper presented at Annual Convention of N.A.P.R.E., at San Francisco, Calif., Dec. 1, 1927.

# REFRIGERATION *Equipment and Operation*

sets the valves according to their sound to his trained ear and then watches the frost line or pressure change in the suction pipe for results. Better-equipped plants have thermometers and gages at important points in the system which indicate to the operator the effect produced by a certain setting of a valve and serve as guides to him when deciding whether it is set properly or whether it should be slightly opened or closed. These instruments indicate only, they do not perform.

In plants of simple design the proper regulation of the liquid can be accomplished satisfactorily, but in plants where there are many valves, several compressors, and great fluctuations in temperatures and loads, hand regulation becomes irksome. Many sleepless nights and serious damage to machinery, to the ice in the process of freezing and to the products in storage, have been caused by the improper manipulation of liquid control valves. We can appreciate, therefore, the wonderful possibilities and advantages of an automatic control valve that will know what ought to be done and do it promptly.

No automatic valve can be made that will properly serve all purposes. The valve of greatest utility is the one that will perform well under the greatest number of common conditions to which it will be subjected.

There are four types of automatic control valves in common use: Stop valves, designed to open and close quickly; constant-pressure valves, designed to maintain a definite suction pressure; constant liquid-level valves, designed to keep the liquid in the evaporators at a definite level and load-demand valves, designed to control the liquid supply in proportion to the load demands upon the evaporator.

Stop valves do not attempt to regulate gradually the quantity of liquid flow, but function by opening wide and closing tight, and are usually followed by an expansion valve. The operating mechanism is either a solenoid or a small motor, electrically wired to a thermostatically controlled switch located in the room or brine tank. When the temperature in the room or brine tank is too warm, the thermostat closes the switch, causing the solenoid or motor to open the valve wide. When the temperature has been reduced to a predetermined point, the thermostat breaks the circuit or reverses the current, and the valve closes. If the compressor motor is to be automatically started and stopped, a second switch acting in harmony with the first and wired to the compressor motor starting switch, starts the compressor when the stop valve opens and stops it simultaneously with the closing of the valve.

We see that the automatic liquid stop valve when operating in connection with an automatically controlled compressor, possesses the advantage of keeping the ammonia bottled up just where it was at the time the compressor shut down; but when the compressor starts, it does not permit pumping back the evaporated gases before new liquid is introduced. When operating in connection with a compressor running continuously, every time the automatic stop valve closes, the ammonia is pumped out of the evaporator until the suction pressure equalizes with that in the rest of the system.

Constant-pressure valves have been in use for many years, all being of the same general design, which function by the pressure in the evaporator working upon the valve diaphragm to reduce or increase the supply. A modification of this valve operates by changes in condensing pressure instead of suction pressure. Assuming that constant-pressure valves perform exactly as they are intended to, it must be quite obvious that their application should be restricted to operations where uniform evaporator pressures are desired.

Valves of this type do not adjust themselves automatically to changes in loads, temperatures, liquid levels, degrees of superheat or other variables of plant operation, but focus their entire attention toward keeping the suction pressure constant. An operating engineer

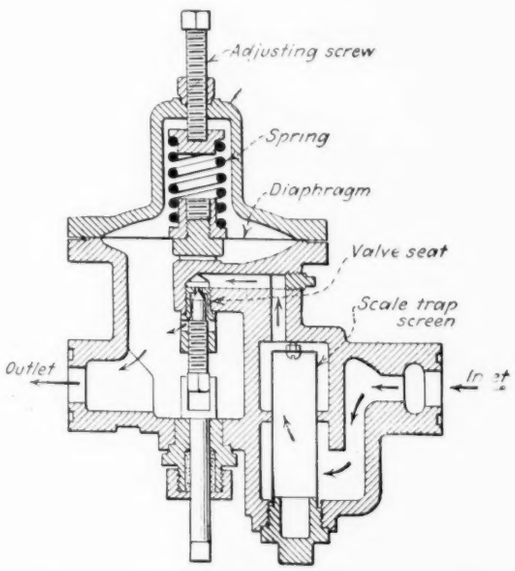



***Fig. 1**—Baker-Hoffman load-demand valve*

will cut down on the valve as the load falls off, in order to prevent liquid from returning to the cylinder. Likewise, as the load increases he will ordinarily open the valve in order to get the maximum benefits from the evaporators and compressors.

Constant-pressure valves have been applied generally to small automatic plants for most markets, restaurants, cold storage, etc., where the load demands have been fairly constant, at least during certain seasons. They are usually adjusted for an average load condition, so that by the time the boxes are cold and the suction gases are heavily charged with liquid ammonia, the plant is ready to shut down. Valves of this type operate best when working on a single evaporator or with several evaporators in series. They cannot be satisfactorily adjusted when two or more are installed in the system, because the pressure created in the evaporator fed by a particular valve will affect every other valve, perhaps closing some that should be opened or opening some that should be closed.

They have the advantages of being simple in design, comparatively inexpensive, and of closing off the supply

# REFRIGERATION *Equipment and Operation*

to the evaporators just as soon as the pressure builds up beyond a predetermined point, even though the compressor is not running.

Constant liquid-level valves are made with a float arrangement which opens the valve when the liquid is below a certain level and closes it when higher than the mark. In large plants they are used both on liquid

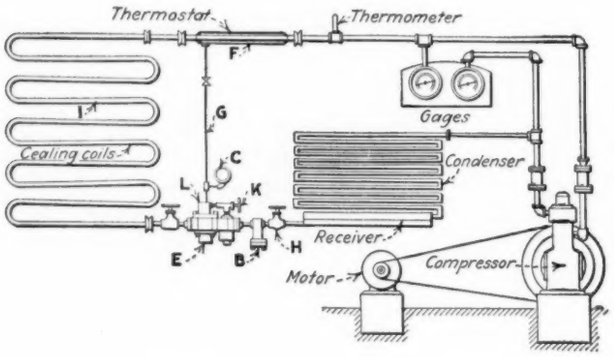



*Fig. 2—Diagram of a refrigerating system with a load-demand valve*

receivers and on brine coolers. It must be quite obvious that these valves are not to be recommended on evaporators where it may be desirable to increase or decrease the capacity of the cooler by raising or lowering the liquid level. They are used extensively on household machines. In apartment house work where several evaporators are connected to a single compressor, they are applied in multiple. The compressor automatically starts through the action of a pressure-controlled switch when the pressure in the suction line reaches a certain high limit, and shuts down when the pressure is reduced to the low limit. The use of valves of this type is restricted to evaporators specially constructed to receive them.

Load-demand valves are connected into both the liquid and the suction lines. They function by controlling the liquid feed in proportion to the load imposed upon the evaporator as indicated by the temperature of the gas leaving the evaporator.

This valve is shown connected to the system in Figs. 2 and 3. *H* is the liquid king valve, *B* the scale trap, *K* the charging valve, *F* the thermostat pipe, *G* a line from thermostat to the valve diaphragm and *L* the adjusting screw.

To put the valve into service, the king valve *K* is closed and a vacuum pumped on the low side. The king valve is then opened and the thermostat charged with liquid ammonia through valve *K* until the pressure gage reads about 75 lb. This fills that portion of the control valve above the diaphragm and the pipe connecting it to the thermostat and partly fills the thermostat with liquid ammonia, leaving space for the expansion and contraction.

The amount of expansion or contraction of the ammonia thus confined in the thermostat will be governed by the temperature of the gas leaving the evaporator. This in turn controls the pressure on the valve diaphragm and regulates the flow of liquid to the evaporator.

The valve is set for a predetermined degree of superheat of the suction gas, for example, ten degrees above the saturated temperature. A lowering of this temperature of superheat indicates that the evaporator is not boiling off the ammonia as fast as it is being supplied, and the valve automatically reduces the supply. An increase in the temperature of superheat automatically opens the valve slightly and increases the supply into the evaporator.

While this principle of control will not satisfy every operating condition, it more nearly approaches the ideal than any of the others mentioned. The most attentive and skillful operating engineer who desired to operate his plant with the object of securing the highest possible efficiency, would follow this principle and try to control the liquid feed in exactly the same manner that this valve is designed to control it.

The valve is much more sensitive, however, and responds much more quickly to any changes in loads than can be done through manual control. Consequently, it performs more effectively. As this valve is designed to open with a rise in the suction temperature, an automatic liquid stop valve must be placed ahead of it when applied to automatically controlled compressors in order to prevent draining the liquid receiver.

The Baker-Hoffman "non-freeze-back" valve is a load-demand valve. It will keep the liquid out of the compressor, but "freeze back" under certain conditions may be highly desirable. For example, let us assume that we wanted to maintain a temperature of 14 deg. F. in a

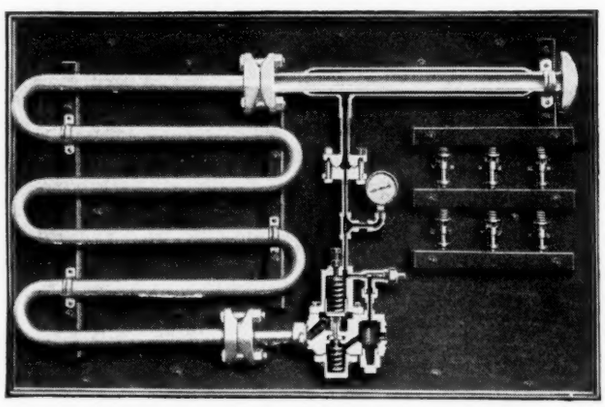


*Fig. 3—How the valve is connected to the compressor suction line*

brine tank, with the saturated temperature of ammonia 6 deg. F. corresponding to 20.4 lb. gage pressure. It would be ideal to have the gases return at 6 deg., but for practical reasons and to prevent the possible return of liquid ammonia, we superheat it 10 deg. This would give a temperature in the evaporator that would most certainly cause frost on the suction line, but at the same time it would do no harm to the compressor. A valve correctly set for maximum results will return the gas to the compressor entirely evaporated and with as little superheat as possible, because after the liquid ammonia

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has been completely gasified, it can do no further useful work. On the other hand, if this gas becomes superheated, it reduces capacity by occupying space in the evaporator which should be occupied by useful liquid, and by building up a superfluous volume that prevents the cylinders of the compressor from filling with the quality of gas that will enable it to perform maximum duty.

Under normal operation a change in the degree of superheat is a certain indication of liquid level in the evaporator. The effective work is done by the wetted surface of the evaporator, while the harmful superheating is done by the dry surface.

A valve of this design applied to a brine cooler or an ice-making tank will control the temperature of the return gas, maintain the proper liquid level and crowd it to its maximum capacity without permitting it to "slug back" on the machine. On the other hand, when the evaporator load drops off for any reason, the temperature of the suction gas becomes colder and the valve automatically cuts down the feed. Its action is so quick and positive that a brine recording thermometer chart instead of having the usual temperature fluctuations, shows a uniform brine temperature and looks as if it had been scribed with a compass.

## Why the Ring Around an Ice Cake?

By William S. Hobbs

ONE of the troubles experienced in many plants is the presence of a cloudy ring about the ice near the top. Why the ring exists is a problem that few people are able to solve.

Many ice pullers and operating engineers have been accused of various negligences, such as thawing the ice from the cans too long. In fact, this accusation is the first one brought up by most managers. The ice puller knows from experience that this is not the cause, but is unable to explain and consequently receives the blame.

My attention was first drawn to this ring in a distilled-water ice plant where the can was totally submerged to loosen the ice. The thawing water became so salty that it was necessary to devise other means whereby the salty water would not enter the cans. Previously, the cans had been well drained, but the salt only dried in the can and polluted the pure distilled water when filled. I suggested that the water in the dip tanks be lowered to the level of the ice; in this way the dip water would not enter the can. As complaints on the ice quality grew more frequent, this suggestion was adopted, with success.

But another trouble developed. A ring was thawed around the block a few inches from the top. Immediately, complaints and accusations were heard: "You are leaving the ice in the dip tanks too long." Perhaps this was true in some instances, but the dipping time was no longer than previously. The most common remark from the unobservant looker-on was that the ring was at the water level on the outside of the can. A few observations and measurements proved this theory to be false. The ring was found to be several inches below the water level on the outside of the can.

A more thoughtful person believed the ring was still due to the level on the outside of the can, but thought the cold can top absorbed a portion of the heat which started through the can near the top and thus kept this portion to a depth of several inches below the water level, colder and, consequently, lowered this thawed ring somewhat below the outside water level. This appeared to be a more logical explanation, but it, too, failed under more severe tests. After measuring and dipping to various depths and adding water to the can and noticing its effect on the height of the ring, and especially taking account of the ring which is formed at the water's edge of a block of floating ice, I arrived at the cause and remedies, which the following statements will make clear:

Hot water, being lighter than cold water, rises to the top. The volume of water is less than the volume of ice melted to obtain this water. Thus the melted ice does not completely fill the space the ice occupied. The level of this melted ice is several inches below the top of the block, the exact level depending upon the quantity of ice melted. The hottest water being at the top, the thawing proceeded more rapidly at this point.

In addition, the coefficient of heat transfer is greater between solids and liquids than between solids and gases. The heat must be transferred by radiation, conduction and convection across an air gap near the top of the ice, and this is very slow compared to the transfer through water. Thus, the submerged portion of the ice thawed very rapidly and especially that near the top of the water level inside the can.

Recently, my attention has been called to the same trouble in an Arctic Pownall, raw-water, stationary-can ice plant. Again, no one in the plant knew the cause. The ice puller had been accused of overthawing by the management and warned not to let that happen often. Others attributed it to bad circulation, and some thought that trash had accumulated near the can tops. In this type of plant the drain valve is opened to remove the thawed ice. However, owing to the spray nozzles under the bottom of the tank or the drains being clogged, a few blocks stuck to the bottoms and prevented the drains from operating, thus causing this water to remain in the can around the ice and producing the deep ring at its upper level.

The Efficiency of the Small Refrigerating Compressor can be materially increased by cutting the clearance volume to the very minimum, so it was stated by C. C. Spreen in *Refrigerating Engineering*. Naturally, there are practical considerations to be taken into account. It would be simple to make the clearance volume very small when constructing one compressor for efficiency only, but it would be quite another problem to make the clearance volume very small when the compressors are made in mass production. The efficiency of the household compressor may be materially increased by better cooling. Wiredrawing at the piston and discharge valves and leakage of vapor past the piston rings and valves affect the compressor efficiency, but are not, for well constructed compressors, as important as the clearance volume and superheating losses.

# EDITORIALS

## How Far Does *Your* Job Go?

MANY an engineer is too absorbed in the little things to see the big ones. He cannot see the forest for the trees. It is all very well for him to devote much of his attention to the technical aspects of his job, but at the same time he should not fail to give some thought to the extent of his responsibility and authority. The following letter indicates how one reader of *Power* describes his job:

> . . . in many instances the man who is responsible for power generation is also largely, if not entirely, responsible for selection of equipment used in its transmission and application to the machinery in the manufacturing departments. It is true in the case of this company.
>
> The company has a master mechanic directly in charge of a shop force which installs and maintains machinery and transmission equipment. The specification of the machinery comes largely from the Production Department, but the engineer passes on the mechanical fitness of the machinery for the duty required, and for the transmission equipment involved, such as couplings, reducers, drives, motors, starters, electric feeders, etc.
>
> In specifying the type of drive to be adopted and the makes of transmission equipment to purchase, we are guided largely by our experience in operating the various types of machinery used in our manufacturing, and by observed performance of the various makes we have had in use or have observed in operation elsewhere.
>
> Whether the drive shall be individual motor, individual group or general line drive depends primarily on the nature of the individual machine as regards its starting characteristics, the running power required, the importance of uniform speed, and the nature of the start as required by the product in the process of manufacture.

How far does *your* job take you, Mr. Reader? Are your specialized abilities and experience being used for all they are worth? Are you spending your time doing things that could be done just as well by an assistant, while important tasks out in the factory are being overlooked or are handled by men with less skill and experience than yours?

Modern industry demands that the best brains shall be applied to every task. Rest assured that your boss wants this done in his plant. But do not assume that he knows all about you and every detail of your ability. He has troubles of his own—finance, sales, management, development. Is there a job in your factory that you could do better than it is being done now? Go after it. Don't hem yourself in with a wall of indifference or buck-passing, until you become a little information bureau for giving answers when people ask you about minor technical details of the outfit, for as surely as you do this, they will forget to ask you about the really important things. And by experience and training you are peculiarly well equipped to discuss many questions of vital importance to your firm.

Be a man of consequence throughout the establishment you serve.

## The New Spirit in American Industry

MACHINES are but an extension of man-power, supplementary muscles, as it were, by means of which a single worker today achieves what scores could not accomplish in the past. To operate modern machines successfully probably requires less manual effort and more brain-power than industry has ever needed before. Fortunately, this headwork and handwork are abundantly available.

But co-ordination of hand and head do not alone suffice to make a manufacturing plant successful under modern conditions of competition. In fact, it is the experience of the American Rolling Mill Company, one of the outstanding successes of industrial America, that these two factors together form only the lesser part of the requisites of success. The greater part, according to the executives of this great concern, consists of the things of the spirit. Only upon mutual understanding and co-operation, upon a common interest of employees, management and stockholders in the welfare and happiness of the community in which the industry is located, can be founded that environment in which an industry can develop to the full.

In the development of these unmeasurable conditions the American Rolling Mill Company, though perhaps in the van, has not been alone. There is a new spirit that is coming to characterize American industry. More often than before, industrial plants with no measurable superiorities of physical or technical resources over their competitors, stand out as leaders. It is because of this new spirit of mutual confidence and co-operation.

If this spirit is to grow—and it must if our country is to gain in full the rewards of modern industry—management must take the lead. Not in a spirit of paternalism, but simply because any movement must have a leader, plant management must take this responsibility. The advantages to be reaped from seeing that the physical, mental and spiritual environment of a plant are such as to insure a happy, contented life and a spirit of willing co-operation are as open to the small plant as to the huge

industry. "Armco" was a small industry when this policy was initiated, twenty-eight years ago. The important point to remember is that it is the "odd eight hours," when a man is neither working nor sleeping, that are most important in determining how that man will think and act.

## Automatic Stand-by Power Plants

THE stoppage of manufacture through the breakdown of the power supply is not uncommon, and insurance against such a disturbance is being written by several companies. However, the insurance seldom fully covers the damage, especially since most shutdowns are far too brief to be officially classified as such.

In hotels, office buildings, theaters and other places of public gathering a shutdown of even a few minutes may result in a panic and ultimate financial loss greater than in a factory. Safeguard against interruption rather than insurance against loss is the important factor.

Duplicate feeder lines from the central source of electrical supply is prevalent, but this may be costly and does not protect against an outage of the generating plant. The breakdown equipment must be closer to the place of consumption. To this end attention is being given to small generating units located on the consumer's premises and arranged to start automatically whenever the main power goes off.

A few installations of waterwheels direct-connected to small generators have been made. These obtain the necessary water from the city water mains, and although the generating costs are high, the service is actually cheap since it is so seldom used.

Other buildings have installed gas-engine sets, but those have been non-automatic. There is no reason why a complete automatic gas-engine set of considerable size cannot be developed along the lines of the farm lighting set. Why not try it?

## Dissociation or Evaporation

WITH present boiler practice the high rates of evaporation effected in the tubes directly exposed to the fire have far exceeded what were formerly believed possible in the formation of steam. The appreciable time involved in the formation of a bubble and its reluctance to break away from the surface of the metal were apparent.

Alex Dow advances a theory to account for the rapid formation of steam under such conditions, which is most interesting. He is of the opinion that, at these high rates, there is actual dissociation of the water at the tube surface into hydrogen and oxygen atoms which recombine immediately to form steam without the loss of heat. That this dissociation occurs at temperatures somewhat lower than has been found experimentally, he attributes to the action of a catalyst in the form of an iron-oxide coating on the inside surface of the tubes. In support of this he points out that the formation of steam is less rapid in tubes with perfectly clean surfaces.

If this latter explanation be accepted, it would be interesting to compare the results attained as between an ordinary tube coated with iron oxide and one that has been polished and chromium-plated on the inside.

Doubtless, many engineers will not be in agreement with the theory. *Power* has no opinion to offer other than to point out that even such an unusual idea as this, coming from a man of Mr. Dow's standing as an engineer, who has pioneered and accomplished things, warrants careful consideration.

Constructive discussion by those qualified through experience in physical chemistry would be illuminating, and a final answer to the problem might be had through laboratory investigation. If the latter should prove Mr. Dow's theory to be without foundation, he would cheerfully accept the result. On the other hand, if his theory be confirmed, it would have a far-reaching influence upon many of the problems now confronting designers who are endeavoring to meet the demands of present operating practice.

## Imagine the Savings!

IMAGINE what a difference it would make in the power requirements of some industrial plants if the power transmission shafts and hangers were the most suitable that could be obtained and were always maintained in efficient operating condition. A large silk mill, apparently faced with the necessity of extending its power plant, checked up on this equipment, and found that the power being wasted there was amply sufficient to take care of the proposed increase in load. Some maintenance work on the shafts and the installation of antifriction bearings in the hangers saved a large capital investment and an increase in operating charges.

The power engineer naturally desires to supply the services, for which the manufacturing departments depend upon him, at the least possible cost. To do this, it is evident that this power transmission equipment must be at maximum efficiency. He can be sure that it is only if it comes under his oversight. But many plants have not yet seen the wisdom of this arrangement.

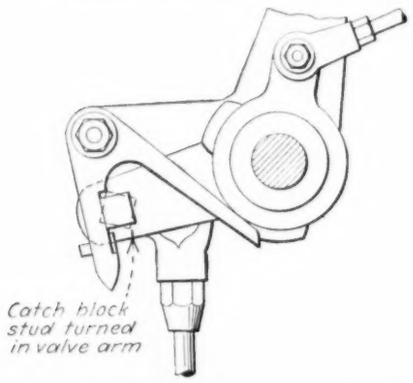
And the management, of course, does not desire to incur any unnecessary capital and operating charges. Unfortunately, however, management often fails to realize how much waste a few feet of lineshaft and a few dozen hangers can cause. But if this fact were recognized and the care and maintenance of such equipment were always assigned to the power engineer, imagine the savings that could be made!

# IDEAS *from* PRACTICAL MEN

*Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted*

## Why the Trip Hook Would Not Hold

IN THE plant in which I am employed, trouble was had with the trip hook on one of our Corliss engines slipping off the catch block on the head-end steam valve crank, preventing the admission valve from opening properly. The trouble could be remedied temporarily by




*Turning of stud made latch slip off*

changing the hook and catch blocks, but in a short time the hook would slip off again.

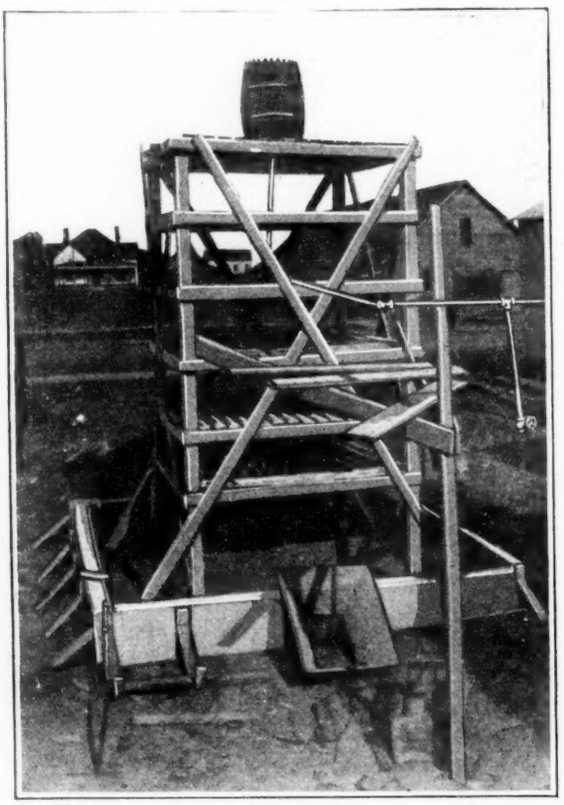
On examining the hook and catch blocks closely, it was noticed that the catch-block stud had become loose enough in the steam arm to allow it to turn slightly toward the hook, as shown exaggerated in the sketch. After turning the catch-block stud back to its proper place and securing it there, the trouble disappeared.

St. Mary's, Ohio. EARL STONEROCK.

## Cooling Tower for Small Internal-Combustion Engine

THE accompanying illustration shows a home-made cooling tower for cooling the jacket water of an internal-combustion engine. A concrete basin 6 ft. square was first built at a convenient location adjacent to the engine room. The walls of the basin were made 4 in. thick at the edges, and the floor was sloped from the sides to a point at the center. Over this basin was then built the 4-ft. square tower shown in the photograph. The tower was made by erecting four pieces of 3x3-in. lumber vertically and nailing cross-pieces one foot apart as shown. Then racks were built of small pieces of lumber with ¼-in. spaces between the pieces. The pieces in each rack are placed at right angles to those in the one next to it. On top of the tower at the center is placed a 30-gal. wooden barrel. The top head of the barrel was removed and the upper ends of the staves notched by sawing out small triangular blocks from their ends with a handsaw. A one-inch pipe line is then connected with the water jacket of the engine cylinder and extends horizontally out of the room a few feet above the ground, and then vertically upward through the tower to the bottom of the barrel.

From the basin a drain line, fitted with a screen on the inlet, is run below ground level to the engine, and a small belt-driven centrifugal pump circulates the water through the engine jacket and to the tower. When the



*Home-made cooling tower for jacket water*

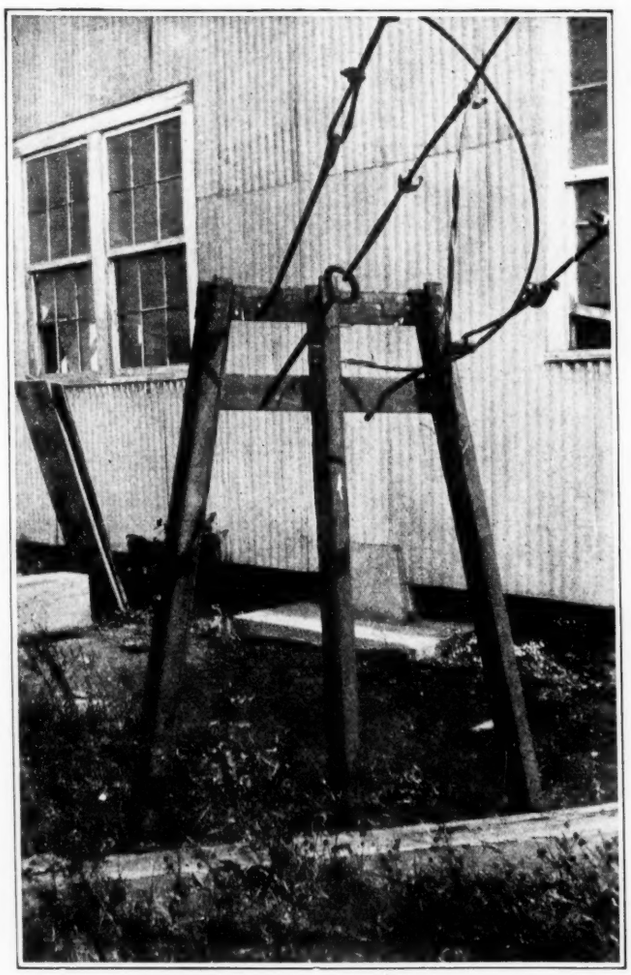
barrel becomes filled, the water runs out through the several notches in the ends of the staves and trickles down the side of the barrel and over the several racks in the tower, where it is spread out thinly and becomes cooled, through being exposed to the atmosphere finally collecting in the basin to be recirculated by the pump. The supply of water is readily replenished by pouring more water into the concrete basin.

Cairo, Ga. L. M. JORDAN.

## Substantial Guy Anchor for Steel Stacks Made from Railroad Rails

USUALLY, when it is necessary to use guy lines in supporting smokestacks, etc., an anchorage for attaching the lower ends of the lines to the earth is made by setting up a wooden stake or piece of timber in the earth and merely tieing the end of the line to this. These wooden anchorages decay in time and have to be replaced, and there is no way of adjusting the tension of the lines other than untieing them. The anchor shown in the illustration is substantial and is convenient for adjusting the tension on the guys and for drawing the stack plumb when it is being erected.

The anchor was made of three pieces of railway track steel 10 ft. long. An excavation was first made in the earth at the place where the anchor was to be set up, 1 ft. deep and 5 ft. square. The three pieces of track steel were then set in holes 5 ft. deep dug with a post-hole digger in the bottom of the excavation in the position shown, all three being inclined slightly away from the stack, the center one being in the same plane as the stack and the one on each side inclined toward the top end of the center one. The earth was tamped tightly around their lower ends in the holes, and the excavation was filled with concrete and allowed to set. This concrete base adds greatly to the sturdiness of the anchor and prevents the steel pieces from becoming loose in the earth.



*Stack anchor made from pieces of railroad rail*

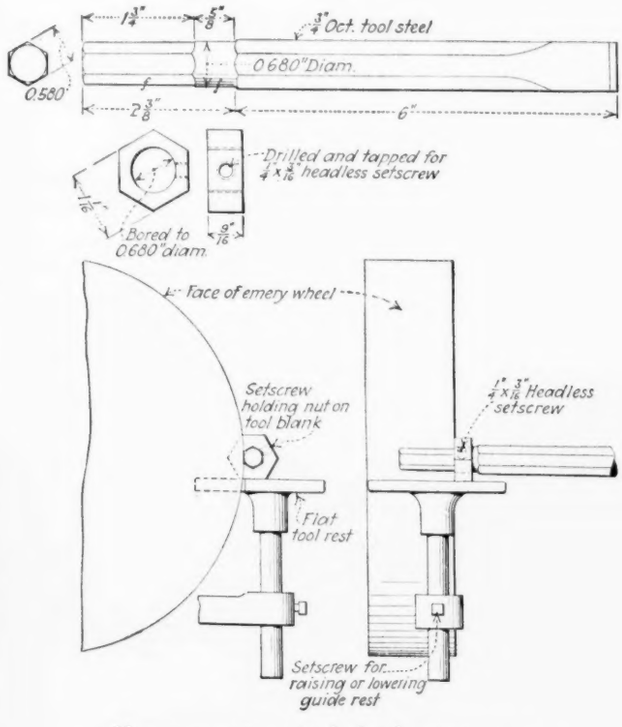
Two pieces of $\frac{1}{2}$-in. flat iron are bolted on the back, or flat, sides of the rails. Then $\frac{1}{2}$-in. holes are drilled through the bars between the upper ends of the rail. Each of the guy lines is attached to the end of a $\frac{1}{2}$-in. iron rod by bending one end of the rod into an eye and attaching the cables with clamps. The end of each rod is threaded for several inches to provide for adjustment of the tension on the guys and for drawing the stack plumb.

J. M. LINCOLN.

Cairo, Ga.

## How Hexagon Tools Were Formed In an Emergency

SOME time ago we were in urgent need of a few chisels and special tool blanks to use with a pneumatic chipping gun. As it would have taken a week or more to get these, we decided to make our own. In order to get a true hexagon on the end to fit the gun, we slipped a $\frac{5}{8}$-in. hexagon nut over the shank of the tool to serve as a templet. The nut was fitted with $\frac{1}{4}$-in. setscrews to hold it in place on the tool while grinding.




*Hexagon nut on tool shank* ***serves*** *as a template for grinding*

By grinding a small amount, using the hexagon sides of the nut as a guide, the hexagon was formed on the tool shank. After being ground and dressed with a file, the blanks were hardened on the small end and were ready to be drawn to the shape of the different tools we required.

G. H. ENGLEHART.

Holbrook, Pa.

# COMMENTS *from* READERS

## *Starting an Oil Engine*

I HAVE read various letters in recent issues of *Power* on the method of starting a Diesel engine when the starting-air bottles are empty.

Since then, I happened to visit a small plant containing one Diesel engine of the air-injection type. I noticed that there was no auxiliary air compressor, so I asked the chief how he had started up the first time.

The operation was as follows. The crankshaft was stripped of all connecting rods to lighten the friction load. An electric motor was mounted on a temporary timber bed and belted to the flywheel of the engine. This motor was then started up and operated until the built-in compressor of the engine had filled all the air bottles to full pressure. The motor belt was then removed, the crankpin bearings reassembled and the engine started on the air in the bottles. If electric power had not been available, a gasoline engine would have been used instead.

HOWARD LIVINGSTON.

Los Angeles, Calif.

[The cost of a small gas-engine driven compressor is so little that the procedure outlined is never justified. —Editor.]

* * * *

## *The Pressure in a Siphon*

I WAS interested in reading the "What do you know" column in the Jan. 3 issue and would like to question the general answer given to question No. 2, in reference to the pressure at the apex of a siphon. I am afraid the apparently simple solution will be misleading to some, for even though the difference in elevation of the two water surfaces is only 15 ft., if they were a considerable distance apart or the entering leg up to the crest was of considerable length, the siphon might not operate at all, owing to excessive losses.

May I suggest the following solution based on the well-known Bernoulli equation of energy: (Pressure energy + kinetic energy + potential energy) at point of beginning = (Pressure energy + kinetic energy + potential energy) + (losses in energy) at point of ending.

Assume the siphon pipe to be 6 in. in diameter, in good condition (for which friction factor = 0.025), and 30 ft. long; the entering leg to be = 7 ft., and the exit leg from the crest to the lower reservoir to be 23 ft. Then

$$\frac{P_1}{W} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{W} + \frac{V_2^2}{2g} + Z_2 + \text{losses between the tanks.}$$

Since there is atmospheric pressure on both tanks, we may cancel these terms; also, considering the reservoirs large, the velocity of the water in a vertical direction is very small, hence the kinetic energy terms become zero for practical purposes. There is a loss at entrance to the siphon equivalent, say, to $0.9\frac{V_p^2}{2g}$, a loss in friction in siphon equal to

$$\left(f\frac{l}{d}\right)\frac{V_p^2}{2g} = \left(0.025 \times \frac{30}{\frac{1}{2}}\right)\frac{V_p^2}{2g} = 1.5\,\frac{V_p^2}{2g},$$

and a loss at exit from the siphon equivalent to about $\frac{V_p^2}{2g}$. This gives for our equation between

$$Z_1 = (0.9 + 1.5 + 1)\,\frac{V_p^2}{2g} = 15,$$

or $\frac{V_p^2}{2g} = \frac{15}{3.4}$, which represents the kinetic energy in the pipe.

Now let us write the energy equation between the top tank and the crest of the siphon as follows:

$$\frac{P_1}{W} + \frac{V_1^2}{2g} + Z_1 = \frac{P_c}{W} + \frac{V_c^2}{2g} + Z_c + \text{losses.}$$

Taking the barometric pressure at the tank as 34 ft. abs. and $V_c = V_p$, we have:

$$34 + 0 + 15 = \frac{P_c}{W} + \frac{V_p^2}{2g} + 20 + \left(0.9 + \frac{0.025 \times 7}{\frac{1}{2}}\right)\frac{V_p^2}{2g}$$

or

$$49 = \frac{P_c}{W} + \frac{15}{3.4} + 20 + 5.52,$$

giving $P_c = 49 - 29.94 = 19.06$ ft. of water absolute, or $19.06 \times 0.433 = 8.25$ lb. per sq.in. abs. at the crest of the siphon. The original answer gave this as 6.04 pounds.

This, of course, will be modified by change of length and character of pipe used for the siphon.

However, even in the case cited, there is an error of about 36 per cent, resulting from a lack of consideration of actual conditions, as quoted at the top of page 26 in *Power* of Jan. 3, 1928, and may lead someone into serious difficulties with siphon work.

GRANT K. PALSGROVE,
Prof. Hydraulic Engineering,
Troy, N. Y. Rensselaer Polytechnic Institute.

[The original question was: A siphon is used to deliver water from one tank to another set below the first, and whose water level is 15 ft. below the level in the first tank. If the rim of the first tank over which the siphon pipe curves is five feet above the surface of the water in this tank, what pressure exists in the siphon at its crest, which is at the tank rim? While the original question did not so state specifically, it was intended that the reader should assume that the water was not flowing and that the discharge was closed with a valve.—Editor.]

## *Where Is The Power in a Double-Acting Diesel?*

IN THE issue of Dec. 27, 1927, Donald McFee asks this question and proceeds to discuss and answer it in a way that gives evidence of incomplete understanding of this simple problem.

It is somewhat difficult to follow the logic of the chief when he admits that a double-acting engine delivers almost twice the power of the single-acting one of the same size, but denies that all this extra power is the output of the bottom end.

Where is it developed then, one may ask, as long as the indicator diagrams accepted by the chief as a basis for the calculations are identical for top and bottom?

Allowing for the piston rod, the gas pressure is exerted on a 10 per cent larger area on the top as compared with the bottom area, giving about 10 per cent larger output from the top. That is, roughly speaking, all there is to it, and I submit that the assistant was right and the chief wrong.

When the chief finally was through with his lecture, he had given the top an output of almost 70 per cent in excess of that of the bottom. The chief gets into trouble and creates confusion due to the fact that he mixes up the division of power output from the two ends and the torque variation inherent in all reciprocating engines.

The assistant might have proved his point had the plant been equipped with the hypothetical engine under discussion, by shutting off the fuel to the bottom cylinder and thus forcibly illustrating to the chief that something must have been wrong with his calculations, since such a procedure would have shown that the top end alone, delivered but a little more than half the previous power output.

Quite another question is, however, at what moment the power developed respectively at top and bottom, is released in external or effective turning moment.

The division of work is as stated by the assistant, but for both top and bottom the total output is not delivered immediately in external work, but some of it is stored up as energy used in accelerating the reciprocating masses at the beginning of the stroke; this energy, however, is again released and transformed into effective turning moment by the retardation of the reciprocating masses at the end of the stroke, and in compressing the charge on the opposite side of the piston, a work that is practically all regained by the following expansion.

In addition, the bottom end may be considered as delivering the necessary energy for lifting the moving parts against the forces of gravity, although it would be more correct to consider this work delivered by the excess energy stored in the flywheel from the preceding down stroke, but this work is also all delivered back again in external work during the following down stroke, a work which is, according to our assumption, created in and delivered from the bottom end and must as a matter of course be correspondingly credited to this end.

The diagrams and theoretical considerations which sidetracked the chief are very necessary and useful in drawing the torque-variation curves for a given engine, in an effort to determine, for instance, the size of flywheel required to obtain a certain desirable minimum speed variation of the engine (including of course in the diagrams also the inertia effect of the reciprocating masses), but a calculation covering only the division of work between the two ends is purely a matter of the ratio between the respective effective piston areas, assuming the mean gas pressure to be equal at both ends.

Chester, Pa. GUNNAR KNUTSEN.

## *Keeping Power Equipment Clean*

THE editorial, "Keeping Power Equipment Clean," in the Dec. 13, 1927, issue, emphasized an important feature of power-equipment maintenance. To clean equipment various methods have been devised, such as the use of compressed air piped to each machine, central vacuum-cleaning systems, portable vacuum cleaners and small combination hand blower and vacuum cleaners. All these have their place in maintenance work, and in important plants the use of all of them may be justified.

On electric equipment the dirt that does the least harm is that which is on the outside of the machine and is the easiest removed. The dirt that gets into the windings, the air ducts and the commutator is the most harmful. Dirt in the air ducts not only prevents free circulation of air through the core and coils, but it also reduces the flow of heat from the core to the ventilating air. Dirt that collects in the winding provides a lodging place for oil and moisture, either of which is an enemy of insulation. This is the chief reason why dirt is the cause of so many electrical breakdowns.

Owing to expansion and contraction of the coils with changes of temperature, movement of the coils produced by magnetic forces, and to other causes, fine cracks develop in the insulation, into which the oil and moisture work and carry with them particles of conducting material. If the windings are kept clean, the opportunities are greatly reduced for these destructive actions to occur. In addition to keeping the windings clean, if they are given a good coat of insulating varnish about once a year, or once every six months if the motors are in very damp places, little trouble should be experienced from insulation breakdowns.

As a general utility tool for keeping electrical equipment clean, the combination hand electric blower and vacuum cleaner has an almost unlimited field of application. It can be used as a vacuum cleaner to remove all dust and dirt that is easily removed. Then it may be used as a blower to reach the places in which suction is not effective. After a machine's winding has been cleaned, the hand blower may be equipped with a varnish spraying receptacle and the winding sprayed.

Where windings have been submerged, the blower may be used to circulate air through the machine during the drying process or it may be equipped with an electric heater and used to do the drying, provided the winding is not too severely soaked.

The combination blower and vacuum cleaner has also been found effective as a vacuum cleaner when grinding commutators. If properly located near the stone, a large part of the dust from the grinding operation can be picked up and prevented from going into the machine.

One of the best features about one of these tools is its size, which allows it to be taken anywhere in the plant. The only requirement to put it into operation is electric power, which may be taken from a lamp socket.

Cleveland, Ohio. M. W. WAGNER.

## *Why Do Boilers Drum?*

WITH reference to the several letters that have appeared in *Power* on "Why Do Boilers Drum?" I am inclined to agree with George O. Davis, whose letter appeared in the December 6, 1927, issue, as to the cause of the drumming.

We have a 500-sq.ft. water-tube stoker-fired boiler in our plant that drums at about 200 per cent of normal rating. It is my opinion that the combustion of the gases is not completed before they come in contact with the tubes, and that they are reignited in the combustion chamber.

We can always stop the drumming by closing the stack damper a little. L. R. BENTZ.

Norfolk, Neb.

* * * *

## *Cutting Gasoline Drums Should Be Done with Care*

ON PAGE 72 of the Jan. 10 issue, an article by L. M. Jordan of Cairo, Ga., advocates the use of gasoline or oil drums cut into halves lengthwise with the oxy-acetylene blowpipe for protecting belts exposed to weather.

There may be a word of caution desirable in connection with rendering containers that have been used for inflammable liquids available for re-use by means of the oxyacetylene cutting blowpipe. Of course every engineer or careful workman who undertook a job of this kind, would see that precautions were taken to prevent the flash of any remaining material during the cutting operation. However, it might be desirable to record the fact that in cutting apart a used drum, reasonable precautions to prevent any unexpected happening should be taken. This same thing, of course, would apply to any process, even work with a cold chisel, which might be likely to produce a spark in the interior of such a container. T. C. FETHERSTON.

New York City.

* * * *

## *Pressure in a Siphon Crest*

THE answer to Question 2 of "What Do You Know?" as given in *Power* of Jan. 3, is correct if flow through the siphon is prevented by a shutoff located between its intake and its crest. However, under conditions of uniform flow, the pressure at the crest will be considerably greater than stated. Under such conditions the flow-actuating head of fifteen feet is utilized in producing velocity head and in overcoming loss of head at entrance, friction and curvature losses in the siphon, and losses at the outlet. The actual quantitative distribution of the flow-actuating head between these factors depends on the size, shape and roughness of the siphon and on the inlet and outlet conditions. Since these are not given, the problem is indeterminate.

In general, however, it may be stated that the required pressure in the siphon at its crest equals

$$P = 14.7 - 0.433(5 + h_v + h_e + h_{fa})$$

or

$$P = 14.7 - 0.433(20 - h_{fb} - h_o),$$

where $P$ is the required absolute pressure in the siphon at its crest, in lb. per sq.in.: $h_v$ is velocity head; $h_e$ is loss of head at entrance; $h_{fa}$ is losses of head in friction and curvature between the intake and the crest; $h_{fb}$ is losses of head in friction and curvature between the crest and the outlet, and $h_o$ is losses of head at the outlet.

RALPH R. RANDELL, Engineer,
Washington, D. C. Federal Power Commission.

## Answers to What Do You Know

*The questions are on page 139*

Ans. 1—Under ordinary conditions, when the exhaust is condensed to a pressure below 26 in. vacuum, which would be about 2 lb. absolute, the greater cylinder cooling due to the lower temperature of the exhaust, that must be compensated by heat abstracted from the initial steam, amounts to more loss than the increase of m.e.p. obtained by the further reduction of back pressure. This is aside from additional cost of obtaining a higher vacuum.

Ans. 2—The wet-bulb temperature will also be 60 deg. F. Ordinarily, the wet-bulb temperature is slightly above the dew-point temperature, owing to the absorption of heat by the thermometer stem, and below the dry-bulb temperature by reason of the fact that the air is not saturated. In the question, since the air is at the dew point, it is fully saturated and no evaporation will take place, so that the wet-bulb would be the same as the dry-bulb temperature.

Ans. 3—After the compression of the high pressure, which will change the area of the indicator diagram.

Ans. 4—The vibrations are due to lack of sufficient mass in the foundation and can be corrected by increasing the surface area or the depth of the foundation to obtain more mass.

Ans. 5—This is no doubt due to the fact that a considerable amount of the steam is wasted through the atmospheric relief valve. The live steam should be put into the exhaust line through a reducing valve set to pass the steam at a pressure somewhat below that at which the relief valve is set.

Ans. 6—If the load varies, the amount of heat absorbed by the hot bulb may on light loads be insufficient to keep the bulb heated to the proper degree to insure ignition of the fuel.

Ans. 7—Tests prove pulverized coal can be transported by pipe over a mile. In these tests jets of air were placed at intervals along the pipe to insure non-stoppage of the pipe.

Ans. 8—Most two-stroke-cycle gas engines scavenge the cylinder with the mixture of air and gas. The loss of gas through the exhaust ports makes the heat efficiency lower than in case of a four-stroke-cycle engine, where the piston forces the burnt gases out of the cylinder.

Ans. 9—To prevent pounding, the high-speed engine requires more compression. This is for the reason that compression is needed to take care of the inertia forces and these vary with the square of the r.p.m.

Ans. 10—Neither compressor has a relief valve between the cylinder and the stop valve. If the motor was started with the stop valve closed, the cylinder might be broken by the high pressure developed. In addition good practice dictates the placing of the stop valve in the horizontal pipe. As shown, moisture will collect above the valve and set up a water hammer when the valve is opened and the machine started.

# *New and Improved* EQUIPMENT

## Hofft Furnace Arch Block Hanger

TO FACILITATE the installation of furnace arch blocks from the inside of the furnace, the M. A. Hofft

*Fig. 1—View of hanger*

Co., Indianapolis, Ind., has brought out the block hanger illustrated. It consists simply of a Y-casting with two hinged fingers that fit over the lower flange of the beam and support the weight of the block. Fig. 1 shows the

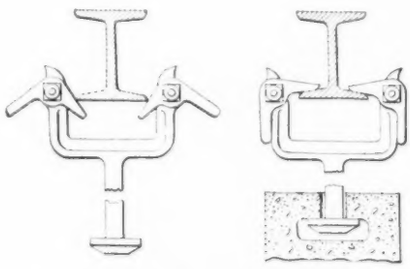


*Fig. 2—How block and hanger are put into place*

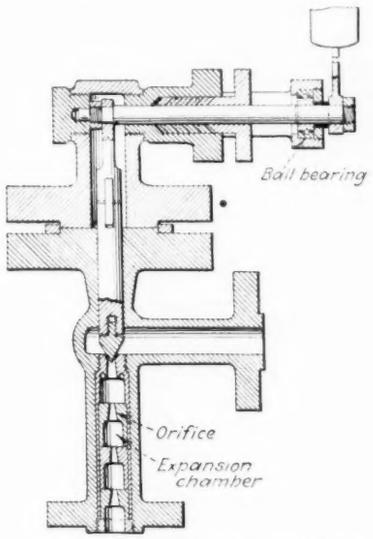
details of the hanger, and Figs. 2 and 3 illustrate how the hanger and block are pushed into place from below.

To put a new block in place, the hanger is inserted in the tile or block and the whole pushed upward until the ends of the hinged fingers pass the lower flange of the I-beam, and automatically fall into position as shown.

The hangers are made in various lengths to suit installation requirements.

## Copes Multiport Orifice Valve for High-Pressure Drainage Control

THE illustration shows the multiport orifice discharge valve for use with the "Copes" condensate drainage con-




*Cross-section through multiport orifice valve*

trol for high pressures, recently brought out by the Northern Equipment Company, Erie, Pa.

The valve illustrated is designed for use with pressures up to 1,500 lb. and for use in place of the single seat and disk valve, which would be subjected to excessive erosion caused by condensate passing through the valve at high pressure.

The pressure reduction, from 1,500 lb. to atmospheric, is through a series of orifices and expansion chambers, and consequently the back pressure set up causes the total pressure drop to be distributed through several stages and the drop across the seat and disk of the valve to be less than 300 pounds.

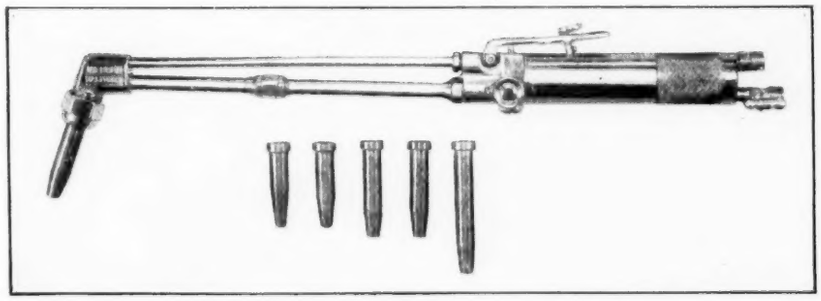
The valve is fitted with a deep stuffing box and an outboard ball bearing to support the extreme end of the shaft. This bearing prevents any spring of the shaft and also takes care of the end thrust. The orifices and expansion chamber sections are carried in a special sleeve, the upper end of which forms the seat for the valve.

## Milburn Type R1 Lightweight Combination Cutting and Welding Torch

THE type R1 combination cutting and welding torch illustrated has been brought out recently by the Alexander Milburn Co., 1416 West Baltimore St., Baltimore, Md.

The torch is designed to operate with oxygen and acetylene, oxygen and hydrogen or other gases, and is readily converted from a cutting to a welding torch by changing the tips. It will, it is claimed, weld the lightest or heaviest metals and will cut metals up to 12-in. in thickness. Its weight is 40 ounces.

The torch has two gas tubes of stainless steel. The torch head, made of forged bronze, as well as the valves, is designed for severe service and continuous operation. The high-pressure

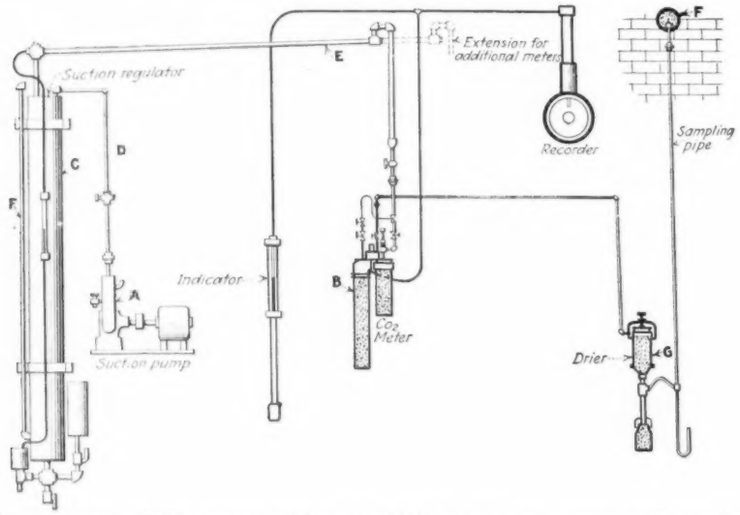


*Lightweight combination torch and set of tips*

cutting oxygen thumb button remains fixed in either open or closed position without sustained pressure from the thumb. All valves are readily accessible. Among other features are good balance, ease of operation and the supermixing of the gases so that a neutral uniform flame results.

## Uehling Electrically Operated Apex $CO_2$ Recorder

WITH a view to simplifying the installation of the Apex $CO_2$ recorder and to eliminating the necessity for steam, water and drain lines in connection with the operation of the instrument, the Uehling Instrument Co., Paterson, N. J., has introduced a motor-operated vacuum pump to operate the instrument in place of the steam aspirator formerly used.




*Arrangement of $CO_2$ meter with motor-driven vacuum pump and regulator*

Referring to the illustration, which shows the various units and the method of connecting, the instrument consists essentially of three principal parts, the suction pump and regulator, the $CO_2$ meter, and the indicator and recorder.

The suction of the vacuum pump *A*, which draws the gas through the meter *B*, is maintained constant by the suction regulator *C*, which consists of a closed vessel filled with oil, the space above which is connected with the pump through the line *D* and to the outlet of the $CO_2$ meter by the pipe line *E*. A pipe *F*, open to the atmosphere, extends into the oil in the regulator near the bottom, and the air bubbling up from it automatically prevents the suction from increasing beyond the point for which the regulator is designed.

A description of the meter, with indicator and recorder, appeared in the Jan. 13, 1925, issue, so a brief review only of the meter will be made. The flue gas flows through the meter continuously, developing a changing pneumatic pressure within it, the magnitude of the changes depending on the percentage of $CO_2$ present in the gas. The $CO_2$ is absorbed in a dry cartridge placed in the meter.

The instrument employs the "pyroporous" filter *F*, which is placed on the the end of the sampling line within the boiler setting to exclude soot and ash.

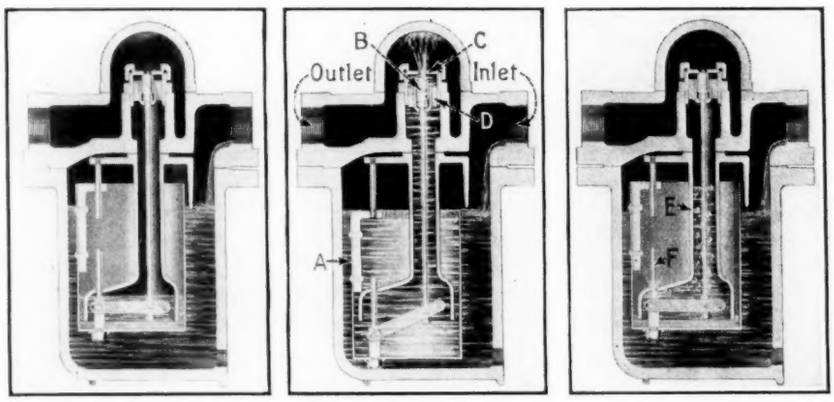
## Wright-Austin "Airxpel" Bucket Traps

AS THE third member of a series of traps, of which the first two are high- and low-pressure float types, a new bucket steam trap has been introduced by the Wright-Austin Company, 315 West Woodbridge St., Detroit, Mich. As indicated by the trade name "Airxpel," the trap is featured by the method of removing the entrained air without loss of steam. Other features are accessibility to the valve and seat by removal of the valve cap and the straight-line horizontal pipe connections to the cover.

There are two forms of the Airxpel trap, designated as "Master" and "Cub" sizes, the former being made for connections from $\frac{1}{2}$- to 2-in. and the Cub sizes, intended for small work, provided with $\frac{1}{2}$- and $\frac{3}{4}$-in. connections. The Master sizes are made in semi-steel for pressures up to 300 lb. and in cast steel for pressures up to 400 lb. The bucket *A* is of copper, the valve *B* and seat *C* are of Monel metal and all other parts are of steam bronze. The Cub sizes are available for pressures up to 200 pounds.

In these traps the valves and seats are reversible and the valve holder *D* has spiral vanes on its side, which rotate the valve during each discharge, this action tending to keep the valve reground and steamtight. Apart from the valve, the valve stem, lever and lever stem with the bucket attached constitute the entire mechanism of the trap. The valve and seat are accessible for reversing or renewing by removing the hood on top of the trap. The seat lifts out when the valve cap is unscrewed, and the valve may be taken out by unscrewing the valve casing and withdrawing a pin. As the inlet and outlet connections are to the cover, the body of the trap can be removed and the bucket disconnected without breaking pipe connections.

Operation of the trap is illustrated by the accompanying halftones. Fig. 1 shows the trap closed shortly after discharge has been completed and before incoming condensate has started to fill the bucket. Fig. 2 shows the trap after the bucket has filled and dropped to the open position, so that the trap has begun to discharge. Fig. 3 shows the trap immediately after the discharge has been completed and the valve closed, but before the water has descended in the discharge tube. This view illustrates the method of air removal. When discharge of the condensate has taken place and the valve is closed by the rising of the bucket, the discharge tube *E* (See Fig. 3) remains full of water. The only way this water can descend into the bucket is by air finding its way into the space above it. This is what happens, as the air entrained in the body of the trap is drawn up into the discharge tube by the descending water seeking its level in the bottom of the bucket. When the trap discharges the next time, the air is forced out first. The air passage into the discharge tube is around the guide rod *F* shown at the left side of the bucket, Fig. 3. As the water descends from the discharge tube and rises in the bucket, the opening around the guide rod is sealed, and the air trapped in the tube is carried away with the next discharge of condensation.




*Figs. 1, 2 and 3—Sectional views, showing operation of Wright-Austin "Airxpel" bucket-type trap*

# NEWS *of the* FIELD

## Dwight P. Robinson, U.G.I., Public Service Production, Day & Zimmermann Now United Engineers & Constructors

### New Company of Four Great Firms Launched with Contracts Totaling More Than $100,000,000—Dwight P. Robinson Selected President—Samuel T. Bodine, Chairman Board of Directors

THE merger, under the name of United Engineers & Constructors, Inc., of four important engineering and contracting organizations, Dwight P. Robinson & Company, Inc., New York; U.G.I. Contracting Company, Philadelphia; Public Service Production Company, Newark, N. J., and Day & Zimmermann Engineering & Construction Company, Philadelphia, was announced Jan. 17.

The new company is launched with contracts in hand amounting to more than $100,000,000. With the work now under way, including the construction of large dams for the government on the Ohio River, extensive hydro-electric developments on the Housatonic River in Connecticut, work in South America and in Spain, and large office and apartmen buildings in New York and other cities, United Engineers & Constructors starts business with an unusual program.

Dwight P. Robinson has been selected president of the new company. Directors include Mr. Robinson, Arthur W. Thompson, president, United Gas Improvement Company, who is chairman of the board of the new company; Thomas N. McCarter, president, Public Service Corporation of New Jersey; Samuel T. Bodine, chairman of board of directors, United Gas Improvement Company; Paul Thompson, a vice-president of the United Gas Improvement Company and president of the Philadelphia Gas Works Company; and John E. Zimmermann, president of Day & Zimmermann, Inc.

Details of the financial features of the plan under which the combination was effected have not been made public but it is understood that an exchange of stock similar to the proceeding in the acquisition of Day & Zimmermann, Inc., by United Gas Improvement Company is involved.

Headquarters will be in Philadelphia but local representation in New York, Newark, N. J., Chicago, Los Angeles, Atlanta, Houston, Pittsburgh, Montreal, Buenos Aires and Rio de Janeiro will be maintained.

Each of the several companies involved has a record for successful consummation of large engineering projects with particular relation to the public utility field.

The U.G.I. Contracting Company's operations date back to 1882, when the United Gas Improvement Company was incorporated to engage in engineering and construction. After the United Gas Improvement Company had branched out into the operation and management of utility properties, it continued the contracting business as a construction department. For years the principal work was building and installing Lowe carburetted water gas plants, patents for which were held by United Gas Improvement Company. The operations expanded, taking in the building of coal, gas and electric power plants and manufacturing and applying road binders.

#### U.G.I. Contracting Operations

The U.G.I. Contracting Company was incorporated in April, 1919. It has built and equipped gas and electric plants, office buildings, factories, bridges, piers, tunnels and roads. It has built more than 1,000 carburetted water gas plants. Recently it acquired the rights to build the German "Stettiner" coal gas ovens in America. Among the steam power plants built by the U.G.I. Contracting Company are the 50,000 kva. Barbadoes Island station, near Norristown, Pa.; the 75,000 kva. Devon, Conn., station; the 37,500 kva. Big Sioux (Sioux City, Ia.) station and the 33,333 kva. station of the Comal Power Company, New Braunfels, Texas. It also built the Stevenson dam and power plant on the Housatonic River in Connecticut and four dams and locks on the Ohio River for the United States Government, which form part of the government's program to make the river navigable at all times. It has under construction extensive hydro-electric developments in Connecticut and Vermont.

Public Service Production Company, a subsidiary of Public Service Corporation of New Jersey, was incorporated Jan. 27, 1922. It built the $33,000,000 Kearny Electric Station, the Harrison gas works of Public Service, as well as a large number of substations, garages and other buildings, and has erected considerable mileage of high tension lines and has done other work of importance for these organizations. It has also built roads in New Jersey, North Carolina and other states, including the so-called "covered cut," the approach to the Holland vehicular tunnel, has erected several important mills and factories and office buildings, including the 18-story Federal Trust Company building, Newark, and has performed many engineering and construction services for public utility, industrial concerns and steam railroads.

#### Record of Day & Zimmermann

Day & Zimmermann Engineering & Construction Company was organized by Day & Zimmermann, Inc., to handle their engineering and construction activities. This firm has a background of over twenty-five years of experience in the layout, design and construction of industrial plants, power plants, transmission lines and wide variety of general structures such as hotels, office buildings, warehouses, and port terminal developments. The 220,000 volt transmission lines from Conowingo to the Philadelphia territory are now under construction by this organization. It has been responsible for the design and construction of hydro-electric and steam electric power plants such as the 60,000 kw. Saxton station for Penn Central Light & Power Company. During the war Day & Zimmermann did work for the United States Army, the Navy, the Shipping Board and the Alien Property Custodian. Included among the projects done for government agencies was the United States Army Supply Base at Philadelphia, comprising the largest piers and warehouses in the port of Philadelphia. For many years Day & Zimmermann have been engaged in the layout and construction of large industrial enterprises such as new plants for the International Harvester Company, American Type Founders Company, Erie Forge and Steel Company, and many others. Institutional work has included such construction as the new dining hall and extension to buildings at Girard College, Philadelphia. Recently, Day & Zimmermann have entered actively the field of hotel and hospital construction and have been responsible for the construction of leading hotels in Rhode Island, Connecticut, Pennsylvania, New Jersey, Virginia and Florida. The work of Day & Zimmermann Engineering & Construction Company is entirely separate from the investigation,

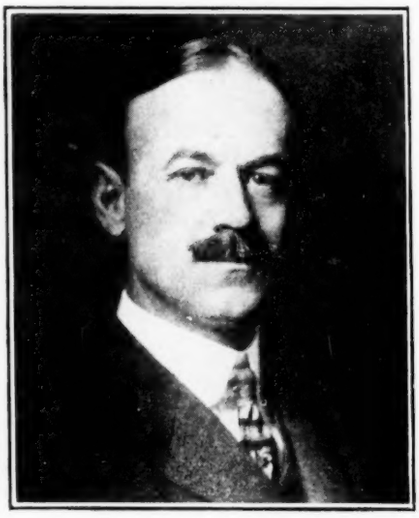
report, and management work which is done by Day & Zimmermann, Inc.

### Mr. Robinson's Career

Dwight P. Robinson has for thirty-five years been engaged in bringing large construction enterprises to completion with speed and economy. He was born in Boston, May 1, 1869. In 1890 he was graduated from Harvard and two years later from the Massachusetts Institute of Technology, where he obtained his electrical engineering education. After graduation, he was an assistant in the mechanical engineering laboratory at the latter institution and in 1893 joined the organization of Stone & Webster. Within a few months he was placed in charge of the Chicago office of that company. From 1895 until 1903 he was engaged in operating light and power properties under Stone & Webster management. In 1903 Mr. Robinson returned to Boston in charge of all Stone & Webster engineering, and when the Stone & Webster Engineering Corporation was formed he was made president in charge of both engineering and construction activities. In 1912 he was admitted to partnership. From 1912 to 1918 he had charge of notable hydro-electric developments in Washington, California, Connecticut, Maine, Georgia and Montana, and the building of steam power stations at Seattle, Minneapolis, Boston, Houghton (Mich.), Savannah, Jacksonville, Tampa, Pensacola, Columbus, Dallas, Fort Worth, El Paso, Houston, Port Arthur, Pittsfield, New Bedford and Bridgewater, Mass.

### Later and Recent Activities

With his organization of unusually capable and devoted men, Mr. Robinson, as the first president of the American International Shipbuilding Corporation, developed Hog Island. He resigned from this company in the spring of 1918 and in the fall of that year he organized Dwight P. Robinson & Company, Inc., New York, to conduct an engineering and construction business. One of the first contracts of this company was for the design and construction of the Colfax power station for the Duquesne Light Company, Pittsburgh, planned for an ultimate capacity of 360,000 kw. In 1920, Dwight P. Robinson & Company absorbed Westinghouse, Church, Kerr & Co., established in 1884, and nationally known as railroad and industrial builders. Dwight P. Robinson & Company has been a leader in the construction of large office buildings, hotels and apartment houses in New York, Chicago, Boston, Buffalo and other cities. Activities, in addition to building work, include the design and construction of steam power stations, hydro-electric developments, substations, transmission systems, railroad shops, freight terminals, electrification of railroads, locomotive and passenger terminals, coaling stations, sugar refineries, smelters, lead plants, fertilizer plants, lumber mills, tanneries, shops, steel mills, foundries, textile mills, chemical plants, pipe lines and pumping stations, filtration and disposal plants, harbor and dock works. The company has performed a large volume of work abroad. The principal contracts consist of irrigation projects for the Brazilian Government in northeastern Brazil, the construction of the Embassy of the United States at Rio de Janeiro and of the exhibits buildings during the Brazilian-Centennial Exposition, and the erection of an office building for the Rio de Janeiro Tramway, Light & Power Company, now in progress. In addition, important work is now being undertaken in Argentina.



*Dwight P. Robinson*

During the past week a staff of Dwight P. Robinson & Company engineers sailed for Seville, Spain, to execute a second contract for the United States Government for the construction of a consulate building and two exhibition buildings for the Iberian-American Exposition.

## Foreman Training Courses in All Lines Show Increase

A great increase in the number of foreman training courses in practically all lines of industry throughout the country is shown in a survey report just issued by the Department of Manufacture of the Chamber of Commerce of the United States. The number of foremanship courses, the bulletin shows, has grown from 105 in 1925 to 933 in 1927. These figures, the Chamber's Department of Manufacture points out, indicate that foreman training is looked upon as an agency for greater efficiency in manufacturing.

Most of the increases in foremanship courses last year were in the larger industrial states. The outstanding increases for the year were recorded in Connecticut, Michigan and West Virginia. The first state increased from 3 to 46; the second from 5 to 73; and the last from 4 to 43.

## Consulting Engineers Meet for Annual in New York

Addition of a new clause to its code of ethics, election of officers and members of the council and addresses on arbitration by Judge Moses Grossman and Col. Charles R. Gow, of Boston, were features of the annual meeting of the American Institute of Consulting Engineers held in New York City Jan. 16 and 17. At the meeting Jan. 16 the following addition to the code of ethics was formally adopted:

"It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of the American Institute of Consulting Engineers:

"(14) To adopt, while serving as an expert witness before any court or tribunal, the attitude of an advocate or to express an opinion not founded on adequate knowledge and honest conviction."

### Speaks on Modern Types of Arbitration Laws

Judge Grossman, honorary president of the American Arbitration Association, addressed the dinner meeting Jan. 16 on the modern types of arbitration laws and the working of them in New York, New Jersey, Massachusetts, Oregon, Pennsylvania, California and federal laws, under which an agreement to arbitrate is binding and irrevocable and wherein decisions have the same binding power as a court decision. Colonel Gow recited his personal experiences with arbitration and the excellent results growing out of its use.

The following were elected to the council for the term expiring January, 1931: Howard C. Baird, New York City; Baxter L. Brown, St. Louis, Mo.; and E. P. Goodrich, New York City. At a meeting of the council at noon Jan. 17, John F. Coleman of New Orleans was elected president, Alten S. Miller, of New York City, vice-president, and P. W. Henry secretary and treasurer (re-elected).

## Private Concerns Purchase 181 Municipal Plants in 1927

One hundred and eighty-one municipally owned electric light and power generating plants, or distributing systems, were sold during 1927 to privately operated companies to be absorbed in more economically operated interconnected systems, according to data presented in a recent issue of the *Electrical World*.

States in which the greatest number of municipal plants were sold were: Nebraska with 22 plants sold; North Carolina, 18 plants; Oklahoma, 15 plants; Georgia, 12 plants; and Iowa and Kansas each with 10 plants sold. Municipal plants in a total of 34 states were involved in the sales to privately operated companies.

# Leading Engineers Chosen as Committee to World Conference at Tokyo, 1929

## Hoover Appoints Prominent Engineers to Study International Co-operation and Problems in All Branches—James H. McGraw and Fred R. Low Among Members

MEMBERSHIP on the American Committee of the World Congress of Engineers to be held in Tokyo in November, 1929, has been accepted by 78 of the nation's most prominent engineers and scientists, Elmer A. Sperry, chairman of the National Research Council, announced Jan. 17. The members were appointed by Secretary of Commerce Hoover, honorary chairman of the committee.

The permanent American committee will promote the aims and purposes of the movement and arrange for attendance of American engineers at the Congress, which should not only serve to cement more firmly the friendly relations between Japan and the United States, but also to throw light on many problems of world-wide importance.

### To Stimulate Sense of Brotherhood

Advancement of international co-operation in the study of engineering science and problems in all its branches, and stimulation of a sense of brotherhood among engineers of the world are the announced purposes of the Congress, which will be the first one ever held, as set forth by Baron K. Furuichi, president of the Engineering Society of Japan. Departments of various governments, universities, institutes and associations are invited to take part in the sessions, which will cover a period of two weeks. The entire enterprise is under the sponsorship of the Japanese government.

### Interest Active Since Baron Shiba's Visit

Unusual interest in the Congress has been apparent among American engineers and scientists since the recent visit of Baron Shiba, aërodynamics authority of Japan, who held a series of conferences here to outline the aims and objects of the project.

"Some of the world's most pressing problems relative to public works, communication and transportation, power, chemicals, textiles and aëronautical and automotive engineering will come befor the Congress," said Maurice Holland, secretary of the American Committee, 29 West 39th St., New York City.

"At the outset the activity in these fields will be taken up under general groupings such as education, administration, statistics and standardization. The sessions will go on to specific problems under the heads of structural work, shipbuilding, mining and metallurgy, fuel, heating and ventilation, illumination, drainage, refrigeration, the use of the telephone and telegraph. Almost every activity of daily life as touched upon by modern science and invention will be reflected in the deliberations of the Congress. It is reasonable to expect that many public problems of moment will be illuminated and the way to their solution pointed by the deliberations of this gathering, in which all leading nations will be represented.

### Leaders to Attend

Among well-known members of the American Committee are Thomas A. Edison, John Hays Hammond, Samuel Insull, William B. Mayo, Ford Motor Company, Charles M. Schwab, Gerard Swope, president of the General Electric Company; Samuel M. Vauclain, president of the Baldwin Locomotive Works; Daniel Willard, president of the Baltimore and Ohio Railroad; Orville Wright, General William Barclay Parsons, James H. McGraw, president of the McGraw-Hill Publishing Company; H. H. Westinghouse, Westinghouse Air Brake Company; Alfred Sloan, Jr., president of the General Motors Corporation; Michael I. Pupin, Columbia University, and William Green, president of the American Federation of Labor.

### Other Members

Others are Edward Dean Adams, William L. Batt, A. W. Berresford, John J. Carty, Everette L. DeGolyer, Gano Dunn, Howard Elliot,t George W. Fuller, Bancroft Gherardi, George Gibbs, Allen Hazen, E. M. Herr, Charles H. Herty, Maurice Holland, John H. Hunt, Frank B. Jewett, John W. Lieb, Fred R. Low, Captain McAlliester, C. O. Mailloux, Wm. H. Nichols, W. W. Nichols, Loyall A. Osborne, William C. Potter, J. V. W. Reynders, Calvin W. Rice, E. W. Rice, Jr., H. T. Sands, John F. Stevens, Elmer A. Sperry, L. B. Stillwell, Calvert Townley, C. B. Veal, W. E. Wickenden, F. L. Hutchinson, H. Foster Bain, George T. Seabury, J. V. Davies, and Robert Ridgway, New York City, John Halligan, Gen. Edgar Jadwin, O. C. Merrill, George Otis Smith and Adm. D. W. Taylor, Washington, D. C.; Howard E. Coffin and Charles F. Kettering, Detroit, A. A. Michelson and Ralph Modjeski, Chicago, D. C. Jackson, A. E. Kennelly, A. D. Little and S. W. Stratton, Cambridge, Mass., Dexter S. Kimball, Ithaca, N. Y., William F. Durand and Charles D. Marx, Stamford University, Calif., Carl E. Grunsky, San Francisco, William Butterworth, Moline, Ill., C. C. Chesney, Pittsfield, Mass., Robert A. Milliken, Pasadena, Calif., John R. Freeman, Providence, R. I., Charles F. Scott, New Haven, Conn., Elihu Thomson, Lynn, Mass., and Ambrose Swasey, Cleveland.

## Project, Effecting St. Lawrence River Plan, Sought

An important projected power development, which indirectly affects the St. Lawrence waterway undertaking, is likely to come to the attention of the Canadian Parliament at the forthcoming session. The documents respecting the proposal are now before the department of railways and canals.

In 1909 the minister of public works granted a lease of certain waters between Lake St. Francis and Lake St. Louis. Now the Beauharnois Light, Heat & Power Company is seeking rights for the development of water power, the ultimate development to be 300,000 hp. A bill to amend the charter of the company was submitted at the last session of the Quebec legislature, but was killed. It is likely that the measure will be presented there again this session. If they are successful this time (all of the water affected is within the province of Quebec) they will go to Ottawa to get certain approval from the department of railway and canals and public works.

It is proposed to construct a new waterway from Lake St. Francis to Lake St. Louis.

## West Texas Utilities Plan Plant—Unit, 20,100 Hp.

Bids for the erection of a building to house the first unit of 20,100 hp. as a part of what ultimately will be the largest electric generating plant planned to date by the West Texas Utilities Company will shortly be received at that company's general office at Abilene, Texas.

The plant will be erected on the north shore of Lake Pauline, five miles southeast of Quanah, and when completed will consist of three units. Construction of the first unit will begin immediately after the contract is awarded and it will be completed and ready for operation by Sept. 1, this year. The two additional units will be built when the need for more power from the plant arises.

The plant, when the three units are finished, will more than double the present available generating capacity of the West Texas Utilities Company, raising the available capacity of 40,000 hp. to 100,000 hp. The unit to be erected this year will add 20,100 hp. which, with 8,500 hp. that will be added by the unit now under construction at the plant at San Angelo, will give the West Texas Utilities Company an available generating capacity of 69,000 hp. after Sept. 1.

## District Heating Course at Purdue University

A short study course will be held at Purdue University, May 21 to 26 inclusive, under the auspices of the National District Heating Association. The work is intended primarily for employees of district heating companies, but will be quite broad in character and of value to anyone engaged in heating work. Attendance will not be limited to members of the association, but will be open to anyone who is interested.

There will be two divisions, an elementary course and an advanced course. In the elementary course such subjects as the fundamentals of heat and the properties of steam heat losses from buildings, and various types of heating and ventilating systems will be studied. In the advanced course the subjects will include distribution system design and construction, operation of heating systems in buildings, meters, and rates.

A similar course was held last year and was well attended. It is expected that a much greater number will be present for the 1928 school.

## Canadian Power Activities Indicate 6,000,000 Hp. by 1930

If the present, and anticipated program of water power development in Canada is carried out according to schedule, a total of 6,000,000 hp. will have been installed in the Dominion by the end of 1930, according to the annual survey by Hon. Charles Stewart, Minister of the Interior. In summing up developments during 1927, the minister points out that the province of Quebec took the lead in the matter of hydraulic installations, mainly through the activities of the Gatineau Power Company, with developments at Chelsea, Farmers Rapids, and Paugan Falls, on the Gatineau River. This company also completed the enlargement of the Rawdon plant of the Quebec Southern Power Corporation, on the Ouareau River, from 300 to 2,150 horsepower.

The largest hydro-electric project at present under construction is the 800,000 hp. development of the Alcoa Power Company at Chute a Caron, on the Saguenay River, while among others the minister mentions a 65,000-hp. work by the Montreal Island Power Company on the River des Prairies; the addition of two 10,000-hp. units to the Canada Northern Power Company's plant on the Quinze River, to be ready July 28; the addition of unit No. 11 of 45,000 hp. to the Duke-Price development on the Saguenay River. Among the larger Ontario developments are the construction of Alexander Landing of a 54,000 hp. work to serve Port Arthur and Fort William; the 56,250-hp. plant of the Spruce Falls River Company on the Mattagami River, and the International Nickel Company's work on the 28,200-hp. plant on the Spanish River. Installations during the year included two plants at Sturgeon Falls and Moose Lake on the Seine River in Western Ontario.

## N. Hawkins, Founder of *Steam*, Dies at the Age of 95

Nehemiah Hawkins, founder of *Steam*, later known by the name of *Power-Steam*, finally shortened to *Power* in 1890, and early prominent as a publisher of technical textbooks under the name of Theodore Audel, died Jan. 15 at his home in Hartsdale, N. Y., in his 95th year, after a four days' illness from pneumonia.

Mr. Hawkins was born in Providence, R. I., Oct. 4, 1833. As a boy he moved

*Nehemiah Hawkins*

to Springfield, Mass., to learn the publishing business with the Merriam Company, publishers of Webster's Dictionary. After a few years his attention turned to the study of engineering, and he soon went to Chicago to learn the contracting business. During the Civil War he engaged in the flour business, and after a number of years became head of the Michigan Flour Mills.

In 1882 Mr. Hawkins founded at Chicago *Steam* as "A Record of the World's Work Performed by Steam Power, and a Popular Science Engineer Monthly Devoted to the Interest of Steam Users." Hence, the paper was originally addressed to two classes of individuals, steam users and stationary steam engineers. It had a circulation of about 3,000 copies, with the subscription rate at $1 a year. About this time Emerson P. Harris and Horace M. Swetland, then young advertising salesmen on the Boston *Journal of Commerce*, were planning a paper to be devoted exclusively to power plants. As a result these two bought *Steam*, which appeared in November, 1884, as *Power-Steam*.

While in Chicago, Mr. Hawkins took much interest in the University of Chicago, which he aided extensively financially.

Removing to New York in 1885, he founded Audel & Company, publishing house, which specialized in engineering textbooks, among which was the well-known "Steam Engineers' Catechism" and other volumes of instruction of the questions and answers type. The firm is now conducted by Mr. Hawkins' son, Victor Hawkins.

Eighteen years ago Mr. Nehemiah Hawkins became paralyzed, but for seven years he remained actively interested in his business, reading, writing, and supervising the publication of books. He retired from business in 1917.

## New Power Station at Leeds, Eng., Modern Throughout

One of the most noteworthy features of the boiler plant of the big new Kirkstall electric power station at Leeds, England, is that boilers of the forged steel drum type, but having riveted ends, are to be used for a pressure of 490 lb. per sq.in. British makers are now developing the manufacture of thick steel boiler drums forged from the solid ingot.

The contract for the complete equipment of the first section of the boiler house calls for it to be ready for operation in 1929. The contract includes three large Stirling type water-tube boilers, having a normal evaporation of 160,000 lb. of water each per hour, operating at 490 lb. pressure and 750 deg. superheated steam temperature, fired throughout by pulverized fuel.

Large self-contained centrifugal roller mills of the usual air-separation type will be provided, together with new rotary driers for the raw coal, operating direct with the pulverizers, and in the combustion chambers, water screens and water-cooled walls. Short-flame burners will be fitted. Each boiler will have feed-water economizers, air heaters, dust extraction apparatus, induced draft and short steel chimneys, and the work includes all the conveying plant for handling the raw coal from scows to the pulverizers or storage dump, the pulverized fuel and the fine residual ash.

## Applies for 21,000-Hp. Water Power Project in Oregon

H. L. Vance has filed an application with the Federal Power Commission for a preliminary permit to install a hydro-electric plant with an ultimate capacity of 21,000 hp., in the Mt. Hood National Forest, Ore. It is stated that the project includes plans for installation of three dams on Eagle Creek and the Lake branch of Hood River; a pipe line and a power house all near Cascade Locks.

The sites are in Hood River and Multnomah Counties, Ore., and it is indicated that the power thus created by the proposed plant would be used for the manufacture of wood pulp.

## Use of Gas as Fuel Topic of Philadelphia Meeting

Utilization of gas as a domestic and industrial fuel was the subject of a meeting held at the Engineers Club of Philadelphia, Jan. 17, under the auspices of the club with the co-operation of the American Gas Association, Pennsylvania Gas Association, American Society for Steel Treating and the American Society of Heating and Ventilating Engineers.

Papers and discussion stressed the point that in any process using heat, the important thing is the final cost of the product with any given source of heat, not the first cost of that heat. It is upon this basis that gas, admittedly higher in cost than other fuels, and likely to remain so, should be given consideration, when choosing a source of heat.

### Potential Market Much Greater Than Present

Formal papers on the topic of the evening were read by Col. Oscar H. Fogg, vice-president, Consolidated Gas Company, New York City, and George E. Whitwell, general manager, The Philadelphia Company, Pittsburgh. Colonel Fogg stated that although gas at present supplies but 2 per cent of the heat demand of the country, the practical potential market is much greater. It is at present used in over 21,000 industrial operations, in which its peculiar advantages, such as low labor requirement, exact control, refinement of process and improvement in quality of product have produced definite economies. Another feature is the steady, but flexible, supply at an unfluctuating price.

### Discusses Lower Gas Prices

The speaker dwelt at some length on the possibilities for future lower gas prices. Cheaper gas seemed to depend largely upon two things: better rate structures and the elimination of peaks in the demand on the gas companies. Other possibilities are the manufacture of chemical or other products from off-peak gas and the reorganization of the gas industry on lines similar to "superpower" movement in electrical generation. In any case, Colonel Fogg looks confidently forward to the day when gas will be the chief, and perhaps the sole, source of heat in most urban communities.

Mr. Whitwell dealt chiefly with applications of gas heat. He emphasized the fact that any installation of gas heat required careful study of all the factors involved, before the true cost of using gas could be determined. After such a study it is always necessary to be sure that the equipment is suitable and the thermostatic control correct if good results are to be obtained.

In the discussion the influence of modern methods of manufacture was brought out. Today goods are generally first made in the laboratory, under the closest of control. If the experimental results are to be continuously reproduced, such control must be applied to the actual production. Gas and electric heat alone permit this, the choice between them being a matter to be worked out in each separate case.

## W. Schwanhausser Dies, Was Worthington's Chief Engineer

William Schwanhausser, chief engineer of the Worthington Pump & Machinery Corporation, died Jan. 15 in Peck Memorial Hospital, Brooklyn, N. Y., after several months' illness. He was 73 years old.

Mr. Schwanhausser was born in

*William Schwanhausser*

Wurzburg, Bavaria. In 1874 he received the degree of mechanical engineer upon being graduated from the Polytechnic Institute in Mittweida, Saxony. He had also had practical experience in the manufacture of machinery prior to his graduation from the engineering school. He early came to America, where he spent the greater part of the last fifty years.

On his arrival in this country Mr. Schwanhausser found employment in the machinery manufacturing company of Osterheld & Eickmeyer at Yonkers, N. Y. A short time afterward he became assistant general superintendent of the Otis Elevator Company. During his eight years' stay with that concern he aided greatly the work of improving the hydraulic elevator.

From 1885 until 1895 he was engaged by the Worthington Hydraulic Works, which at that time was in Brooklyn. During the next ten years he acted as director of the Worthington concern's plant in Germany and introduced Worthington products to all Europe.

Mr. Schwanhausser was a member of the American Society of Mechanical Engineers, Institution of Mechanical Engineers, England.

# *Obituary*

C. E. Colborn, mechanical engineer on the staff of the Elliott Company, Jeannette, Pa., died suddenly from heart trouble Jan. 5. Mr. Colborn was formerly testing engineer with the West Penn Power Company, and an occasional contributor to *Power*.

Edward Larned Ryerson, chairman of the board of the Joseph T. Ryerson & Son Steel Company, resident of Chicago for seventy-three years, died Jan. 19 in his home in that city. Death followed a stroke of apoplexy Saturday. Mr. Ryerson was born in Chicago Nov. 24, 1854. He graduated from Sheffield Scientific School at Yale in 1876. In 1879 he was admitted to his father's wholesale iron and steel firm as a partner and the firm, established in 1842, was renamed Joseph T. Ryerson & Son. From 1888 to 1911 he was president.

# *Personal Mention*

O. S. Lindgren was elected president of the Portland, Ore., post of the Society of American Military Engineers at the annual meeting of the organization held early in January.

Charles M. Ripley, engineer, author and lecturer of the General Electric Company, is in the Pacific Northwest on a lecture tour, speaking before civic organizations, and university and college groups on the "Romance of Power."

Dr. Thomas Stockham Baker, president of the Carnegie Institute of Technology, Pittsburgh, expects to spend six weeks in Europe during February, March and April, to organize plans for the Second International Conference on Bituminous Coal at Pittsburgh.

William H. Ross, secretary of the American Society of Refrigerating Engineers 1904-27, was tendered a luncheon by the board of directors of the Society at the Fraternities Club, New York City, Jan. 12, to mark his election as Secretary Emeritus. The resolution expressing the gratitude of the Society to Mr. Ross for his long and excellent work for the A.S.R.E., will be published in the February issue of *Refrigerating Engineering*.

# *Business Notes*

Allis-Chalmers Manufacturing Company, Milwaukee, has opened a new district sales office at Phoenix, Ariz., covering the states of Arizona and New Mexico and northern part of the Re-

public of Mexico. The office is at 308 Heard Building, with J. B. Cooper as manager. Mr. Cooper's headquarters were formerly in Los Angeles. A branch office has been opened at San Antonio, Texas, 619 Frost National Bank Building, with Earle R. Hury in charge. This is a branch of the district office at Dallas. A branch office is also being opened at Grand Rapids, Mich., Weiss Service Building, with G. C. Culver in charge. This is a branch of the Detroit district office.

BOTFIELD REFRACTORIES COMPANY, Philadelphia, manufacturer of Adamant fire brick cement, announces the appointment of Ires Prosser as Southeastern representative. Mr. Prosser's territory will embrace the entire Southeast from North Carolina to San Antonio, Tex. His headquarters will be Atlanta, Ga.

THE ERIE BALL ENGINE COMPANY, manufacturer of driving generators, fans, blowers, exhausters and paper machines, Pittsburgh, announces that Robert W. Bier took charge of the Chicago office at 1540 Monadnock Block Jan. 1. Mr. Bier, formerly at the Pittsburgh office, was enga ed in shop work as well as sales engineering for several years.

## Trade Catalogs

WASTE HEAT RECLAMATION—Heine Boiler Company treats of the recovery of the waste heat from industrial processes as one of the most important opportunities for reducing operating costs, in the *Safety Valve*, issue of December. The information will be of pertinent interest to any engineer who faces a problem of reclaiming waste heat.

SCREWS, BOLTS, RIVETS, NUTS, ETC.—Pheoll Manufacturing Company, Chicago, has published a catalog for 1928, containing in all 111 pages, giving illustrations and descriptive matter of screws, bolts, rivets and nuts, a copy of which will be mailed to the trade on request. One of the points of interest is that reference tables include the American standard screw threads, and the recently adopted standard dimensions and tolerances for screws, bolts, rivets and nuts.

STEAM TURBO GENERATORS—The purpose of this bulletin published by the American Brown Boveri Electric Corporation, is to describe the operation and construction of normal steam turbines and generators as combined in one unit for central station service. It also describes special turbines that have been developed for special purposes. This bulletin is well illustrated with photographs of various turbine installations and a section is given over to the description of generators with illustrations showing the method of winding them. Several pictures are shown of the 160,000 kw. turbo generator unit to be installed in the Hellgate Station of the United Electric Light & Power Company.

## Coming Conventions

**American Boiler Manufacturers Association,** winter meeting, Hotel Cleveland, Cleveland, Feb. 7; A. C. Baker, sec., 801 Rockefeller Bldg.

**American Institute of Electrical Engineers,** winter convention at New York City, Feb. 13-17, F. Hutchinson, secretary, 29 West 39th St., New York City; St. Louis Regional Meeting, District No. 7, March 7-9; Baltimore Regional Meeting, District No. 2, April 17-19; New Haven Regional Meeting, Northeastern District, No. 1, in May; Summer Convention, in Denver, June 25-29.

**American Institute of Refrigeration,** Washington, D. C., May 10-11.

**American Society of Heating & Ventilating Engineers,** hold general meeting at Hotel Pennsylvania in New York City, Jan. 23-26; A. V. Hutchinson, sec., 29 W. 39th St., New York.

**American Society of Mechanical Engineers,** spring meeting in Pittsburgh, May 14-17; Calvin Rice, secretary, 29 West 39th St., New York City.

**American Society for Testing Materials,** Atlantic City, June 25-29.

**American Water Works Association,** Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

**Association of Iron and Steel Electrical Engineers,** annual convention at Hotel Stevens, Chicago, June 25-29.

**Chicago Power Show** to be held at the Coliseum, Feb. 14-18. G. E. Pfisterer, manager, 53 W. Jackson Blvd., Chicago.

**Midwest Power Conference** to be held at the Hotel Stevens, Feb. 14-17; G. E. Pfisterer, secretary, 53 W. Jackson Blvd., Chicago.

**National Association of Stationary Engineers,** annual convention at Detroit, Sept. 11; Fred Raven, 417 South Dearborn St., Chicago.

**National Board of Boiler and Pressure Vessel Inspectors,** meeting at Erie, Pa., June 18-20.

**National Electric Light Association,** Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

**National District Heating Association,** annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

**The National Marine Engineers' Beneficial Association,** 53rd annual convention, will meet at the Lee House, 15th and L Streets, N. W., Washington, D. C., February 13-18. Albert L. Jones, Secretary-Treasurer, 313 Machinists Building, Washington, D. C.

**Stoker Manufacturers Association,** fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

**Universal Craftsmen Council of Engineers,** Newark, N. J., Aug. 7-10.

## *Fuel Prices*

### COAL

**The following table shows the trend** of the spot steam market in various coals, f.o.b. mines; mine run, except **Pittsburgh gas slack:**

| **Bituminous** (Net Tons) | Market Quoting | Jan. 19, 1928 |
|---|---|---|
| Navy Standard | New York | $2.25@$2.75 |
| Kanawha | Hampton Roads | 1.63 |
| Smokless | Cincinnati | 2.25@ 2.50 |
| Smokless | Chicago | 2.25@ 2.50 |
| S. E. Kentucky | Chicago | 1.40@ 1.60 |
| Steam | Pittsburgh | 1.60@ 1.90 |
| Gas Slack | Pittsburgh | 1.15@ 1.35 |
| Big Seam | Birmingham | 2.00@ 2.25 |
| **Anthracite** (Gross Tons) | | |
| Buckwheat | New York | $2.85@$3.35 |
| Birdseye | New York | 1.60@ 1.85 |

### FUEL OIL

**New York**—Jan. 12, light oil, tank-car lots, 24@26 deg. Baumé, 4¾c. per gal.; 28 deg., 5c. per gal., f.o.b. Bayonne, N. J.

**St. Louis**—Jan. 11, tank-car lots, f.o.b. St. Louis, 24@26 dg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4.3c per gal.; 38@40 deg., 5¼c. per gal.

**Pittsburg**—Jan. 12, f.o.b. local refinery, 30@34 deg., fuel oil, 4½c. per gal.; 36@40 deg., 4¾c. per gal.

**Philadelpia**—Jan. 13, 26@30 deg., $2.00@$2.06 per bbl.; 13@19 deg., $1.26 @$1.32 per bbl.; 22 plus, $1.58@$1.64 per bbl.; 27@@30, $2.10@$2.16 per bbl.

**Cincinnati**—Jan. 16, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

**Chicago**—Jan. 7, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.05 per bbl.

**Boston**—Jan. 16, tank-car lots, f.o.b., 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5.8c. per gal.

**Dallas**—Jan. 13, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

SOOT BLOWERS FOR RETURN TUBULAR BOILERS—The National Flue Cleaner Company, Groveville, N. J., describe "National" soot blowers in a bulletin just issued. These blowers are designed only for use with horizontal return-tubular and Scotch marine boilers. Unlike other types they employ a separate nozzle in a fixed position for each boiler tube, in order to make it impossible for any tube to escape the scouring action of the steam jet. The blower is in the front of the boiler and is operated from the floor level, with either steam or compressed air without interfering with the steaming of the boiler.

# NEW PLANT CONSTRUCTION

**Ark., Osceola** — Sub Dist. 1, Drainage Dist. 8, R. E. Lee Wilson, Jr., awarded contract for the construction of a drainage pumping plant including electrically driven pumping machinery, etc., to Fairbanks Morse & Co., 217 South 8th St., St. Louis, Mo.

**Calif., Fresno**—Pacific Fruit Express Co., 65 Market St., San Francisco, will soon award contract for the construction of an ice and refrigeration plant here. Estimated cost $26,800. Private plans.

**Calif., Glendale**—City will receive bids until Jan. 31 for the construction of a substation.

**Calif., Long Beach** — Ford Motor Co., Highland Park, Mich., is having plans prepared for the construction of an assembly plant including 80 x 98 ft. power house, 62 x 114 ft. oil house, etc., at Long Beach Harbor here. Estimated cost $5,000,000. A. Kahn, Marquette Bldg., Detroit, is architect.

**Calif., Los Angeles**—Bureau of Light and Power, plans the construction of a distribution station at Lincoln Blvd. and Broadway. Estimated cost $75,000.

**Calif., Los Angeles** — County of Los Angeles is having plans prepared for the construction of a hospital including steam heating system, elevators, etc., on Mission Rd. Estimated cost $5,000,000. E. Bergstrom & Associates, City National Bank Bldg., are architects.

**Calif., Los Angeles** — G. A. Hart, 107 Tremont Pl., is having preliminary plans prepared for a 13 story office building including elevators, etc., at Sixth and Figueroa Sts. Estimated cost $1,000,000. J. & D. B. Parkinson, 420 Title Insurance Bldg., are architects.

**Calif., Los Angeles**—Kaspare Cohn Hospital Assn., plans the construction of an 8 story hospital at Catalina St. and Fountain Ave. Estimated cost $1,000,000. Curlett & Beelman, Union Bank Bldg., are architects.

**Calif., Los Angeles**—Kingsley Manor Corp., R. B. Duncan, Pres., awarded contract for the construction of an 11 story apartment building at 626 Kingsley Dr. to Weymouth Crowell Co., 2104 East 15th St. Estimated cost $1,000,000. Steam heating and refrigeration systems, elevators etc. will be installed.

**Calif., Los Angeles**—Los Angeles County, is having plans prepared for a 12 story hospital on Mission Rd. Estimated cost $5,700,000. E. Bergstrom, M. Hunt, W. Richards, P. Davis and S. Hunt, Pacific Desk Co. Bldg., are architects.

**Calif., Los Angeles**—Los Angeles County Medical Holding Co., will soon award contract for the construction of a 13 story office building at Wilshire Blvd. and Westlake Ave.

**Calif., Los Angeles**—Southern California Athletic & Country Club, c/o Meyer & Holler, Wright-Callendar Bldg., Archts., and Contrs., awarded contract for a 13 story club building on Wilshire Blvd. Estimated cost $2,500,000.

**Calif., Los Angeles**—Southern California Telephone Co., 742 South Olive St., plans the construction of a 10 story office building. Estimated cost $1,000,000.

**Calif., Los Angeles**—State of California, plans the construction of a state office building here. Estimated cost $1,250,000. G. B. McDougall, Sacramento, is state architect.

**Calif., Monrovia**—City will soon award contract for the construction of a waterworks system at Norumbega Heights including reservoir, pump house, etc. Estimated cost $35,000.

**Calif., Proberta**—El Camino Irrigation Dist., O. R. Smith, Secy., will receive bids until Feb. 7 for waterworks improvements including six deep well pumping plans, etc.

**Calif., Redlands**—Community Hospital Assn., is having plans prepared for the construction of a hospital including boiler house, 24 x 113 ft. Myron Hunt, 407 Hibernian Bldg., Los Angeles, is architect.

**Calif., San Francisco**—T. Lipton Co., 561 Mission St., is having preliminary plans prepared for a 15 story distribution plant. Estimated cost $1,000,000.

**Colo., Denver**—City will soon receive bids for the construction of a 5 story court house including separate boiler house at Bannock St. between West 14th and 15th Sts. Estimated cost $5,000,000. Allied Architects Assn. of Denver, 412 Insurance Bldg., is architect.

**Conn., Bridgeport**—Southern New England Telephone Co., I. R. Harney, Exchange Mgr., plans the construction of an exchange building on Cortland St. Estimated cost $3,000,000.

**Fla., Pensacola**—Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans the construction of a motor test building at Naval Air Station here.

**Ill., Chicago**—Drake Hotel, Lake Shore Dr. and North Michigan Ave., is having plans prepared for a 30 story addition to hotel at Lake Shore Dr. Estimated cost $3,000,000. B. H. Marshall, 612 Sheridan Rd., Wilmette, is architect.

**Ill., Chicago** — Warren B. Eldred, 6244 Winthrop Ave., is receiving bids for a 6 story apartment building including central refrigeration plant, elevators, etc., at 6244 Winthrop Ave. Lincoln Norcott Hall, 7 West Madison St., is architect.

**Ill., Chicago**—Rissman & Hirschfeld, 228 North La Salle St., Archts., will soon receive bids for a 19 story apartment building at Chestnut and DeWitt Sts., for East Chestnut St. Building Corp., c/o architects. Estimated cost $1,000,000.

**Ill., Chicago**—K. M. Vitzhum & Co., 307 North Michigan Ave., Archt., is receiving bids for a 40 story club, stores and office building at Randolph and Wells Sts. for Steuben Club. Estimated cost $7,000,000.

**Ill., Elgin**—Home National & Home Trust & Savings Bank, will build a 15 story bank and office building at North Grove, Douglas and Chicago Sts. Estimated cost $750,000. Work will be done by separate contracts under the supervision of St. Louis Bank Building & Equipment Co., 900 Sidney St., St. Louis, Mo., Archt.

**Ia., Sidney**—City voted $60,000 bonds for the construction of an electric light plant.

**Kan., Riverside**—Empire District Electric Co., Joplin, Mo., (Henry L. Doherty Co., 60 Wall St., New York, N. Y.) is building a 25,000 kw. frequency changer, also 30 mi., 132,000 volt transmission line here, by day labor.

**Ky., Louisville**—Baltimore Development Co., H. Platoff, Pres., c/o Platoff & Bush, 12220 Liberty St., will build an 11 story apartment building including steam heating system, etc., at Bonneycastle Ave. and Spring Dr. Estimated cost $800,000. Joseph & Joseph, Francis Bldg., are architects. Work will be done by separate contracts.

**La., New Orleans**—Canadian Ice Co., I. Parlet, Pres., plans the construction of an ice plant on Gentilly St. Estimated cost $90,000.

**Mass., Boston**—Homeopathic Hospital, G. B. Glidden, Chn. Building Com., 551 Tremont St., having sketches made for construction of a hospital and medical school. Estimated cost $2,000,000. Kendall, Taylor & Co., 142 Berkley St., are architects.

**Mass., Boston**—Penal Institutions Dept., is having revised plans prepared for the construction of a power house at Deer Island, Boston Harbor. Estimated cost $200,000. Former bids rejected.

**Mass., Brockton** — Cudahy Packing Co., 37 Merchants Row, Boston, will build a refrigeration plant on North Montello St. Estimated cost $50,000. Private plans.

**Mass., Medford** (Boston P. O.)—American Woolen Co., 180 Boston Ave., will build an addition to boiler house. Private plans.

**Mich., Ann Arbor**—University of Michigan Alumni Assn., awarded contract for a 4 story league building including central heating plant to Levering Longbotham Co., Builders Exchange Bldg., St. Paul, Minn. Estimated cost $600,000.

**Mich., Detroit**—Bd. of Water Comrs., 176 East Jefferson Ave., will soon award contract for the construction of an office building including steam heating and ventilation systems, boilers, elevators, etc., on Randolph St. Estimated cost $1,600,000. L. Kamper, Kamper Bldg., Cass Ave., is architect.

**Mich., Detroit** — Stott Realty Co., 409 Lincoln Bldg., will soon award contract for a 35 story office building including steam heating and ventilation systems, boilers, elevators, etc., at State and Griswold Sts. Donaldson & Meier, Penobscot Bldg., are architects.

**Mich., Grosse Pointe Farms** (mail Grosse Pointe)—Village, J. R. Kerry, Clk., will receive bids until Feb. 20 for sewage treatment works and pumping station. Hubbell, Hartering & Roth, 2640 Buhl Bldg., Detroit, are consulting engineers.

**Minn., Rochester**—The Kahler Corp., J. H. Kahler, Pres., plans the construction of a 12 or 13 story hotel including steam heating system, etc. Estimated cost $1,500,000. Architect not announced.

**Miss., DeKalb**—City will receive bids until Feb. 10 for waterworks improvements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including well, reservoir, pumping station, etc. H. A. Mentz, Hammond, La., is engineer.

**Mo., Bollvar**—City defeated bond issue for $40,000 bonds for waterworks improvements including pumping equipment, tank on tower, mains, etc.

**Mo., Cabool**—City, A. C. Hamilton, Clk, will soon award contract for waterworks improvements including deep well, pump house, 300 g.p.m. horizontal centrifugal pump, 100 g.p.m. pump and motor, tank on tower, etc. A. H. Kindrick, 8 Union National Bank Bldg., Springfield, is engineer.

**Mo., Lockwood**—City plans an election Jan. 31 to vote $55,000 for waterworks improvements including deep well, pumping equipment, mains, etc. Alexander Engineering Co., Woodruff Bldg., Springfield, is engineer.

**Mo., Marshall** — City plans an election Jan. 31 to vote $80,000 bonds for extensions and improvements to municipal light plant. Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., are engineers.

**N. J., Allenhurst**—Eastern N. J., Power Co., Hightstown, awarded contract for the construction of an office and laboratory to I. R. Taylor, Asbury Park. Estimated cost $147,000.

**N. J., Allenhurst**—A. E. Fitkin, is having sketches made for the construction of an institute including steam heating system, etc. at Freehold St. and Eatontown Rd. Estimated cost $1,000,000. C. A. Jackson, 461 8th Ave., New York, N. Y., is architect.

**N. J., Elizabeth** — Dry Ice Corp, of America, 50 East 42nd St., awarded contract for the construction of an ice plant on Newark Ave., to H. K. Ferguson Co., 25 West 43rd St., New York, N. Y. Estimated cost $40,000.

**N. J., Elizabeth**—Owner c/o H. O. Hamilton, 369 Lexington Ave., New York, N. Y., Archt. and Engr., is having plans prepared for a 7 story office and theatre building including steam heating system, boilers, elevators, etc. on North Broad St. Estimated cost $1,200,000.

**N. J., Kearny** — Bd. of Council, Town Hall, will receive bids about Jan. 25 for the construction of a booster pumping station and gate house. Estimated cost $800,000. H. B. Kierner, 790 Broad St., Newark, is engineer.

**N. J., New Brunswick**—New Brunswick Hotel Corp., J. E. Mitchell, 362 George St., is having plans prepared for a 10 story hotel and stores building including steam heating, ventilation and refrigeration systems, boilers, elevators, etc. at Livingston Ave. and Schureman St. Estimated cost $600,000. Thomas, Martin & Kirkpatrick, 220 South 16th St., Philadelphia, Pa., are architects and engineers.

**N. Y., Albany** — Bd. of Supervisors, awarded contract for the construction of Ann Lee home to William G. Sheehan Construction Co., 28-30 DeWitt St., also community house including boiler pump house to James J. Finn & Son, Cuyler Ave. Estimated cost $440,000 and $73,335 respectively.

**N. Y., Brooklyn**—Kanros Realty Co., Inc., 350 Stone St., had plans prepared for a 6 story, apartment at Montgomery and Schenectady Aves. Estimated cost $600,000. E. M. Adelsohn, 26 Court St., is architect.

**N. Y., Manlius**—St. Johns School Military Academy, W. Verbeck, is having sketches made for the construction of a dormitory, mess hall and power plant. Estimated cost $200,000. A. B. Trowbridge, 40 East 49th St., New York, is architect.

**N. Y., New York** — Canabbe Holding Corp., M. Cantor, Pres., 50 Broad St., had plans prepared for a 31 story hotel at 371 7th Ave. Estimated cost $4,500,000. Murgatroyd & Ogden, 285 Madison Ave., are architects.

**N. Y., New York**—Corp., c/o R. H. Howes Construction Co., 103 Park Ave., will build a 15 story co-operative apartment building at 168 East 96th St. Estimated cost $750,000. Howard S. Patterson, 124 East 41st St., is architect. Work will be done by separate contracts.

**N. Y., New York**—Forty Fifth St. and Third Ave. Corp., c/o I. Judis, 52 Vanderbilt St., had plans prepared for a 16 story office and loft building at 235 East 45th St. Estimated cost $900,000. E. Roth, 1440 Broadway, is architect.

**N. Y., New York**—Jatison Construction Inc., A. Tishman, Pres., 285 Madison Ave., will build a 9 story apartment at 102 East 89th St. Estimated cost $600,000. Swartz & Gross, 347 5th Ave., are architects. Work will be done by separate contracts.

**N. Y., New York**—State Office Site & Building Comn., A. E. Smith, Chn., Albany, will receive bids until Feb. 14, for the construction of a 9 story state office building at Centre, North and Baxter Sts., here. Estimated cost approximately $7,000,000.

**N. Y., New York** — Stratford Holding Corp., 1440 Broadway, is having plans prepared for four 4 story apartment buildings at Stratford and Watson Aves. Estimated total cost $600,000. Gronenberg & Leuchtag, 1385 Broadway, are architects.

**N. Y., West Haverstraw** — Bureau of Standards & Purchase, Capitol, Albany, will receive bids until Feb. 2 for addition to laundry and boiler room at New York State Orthopedic Hospital for Children, here.

**O., Springfield**—City plans waterworks improvements including reservoir, pumping stations, etc. Estimated cost $400,000. G. B. Gascoigne, Leader Bldg., Cleveland, is engineer.

**Okla., Moore**—City, L. F. Platt, Mayor, will soon award contract for waterworks improvements including deep well pump and motor, etc. Estimated cost $20,000. E. W. Garett, 1116 West Main St., Oklahoma City, is engineer.

**Pa., Mayview**—Dept. of Charities, Pittsburgh, will soon receive bids for a group of buildings including ventilation and refrigeration systems, boilers, pumps, elevators, etc., for city home and hospital here. Estimated cost $1,500,000. Eric Fisher Wood Co., Hardy Hayes Bldg., Pittsburgh, are architects.

**Pa., Philadelphia**—United Gas Improvement Co., Broad and Arch Sts., awarded contract for a coke oven gas plant 5,000,000,000 cu.ft. per yr. capacity at Wheatsheaf Lane and Delaware River to Koppers Co., Union Trust Bldg., Pittsburgh. Estimated cost approximately $8,000,000.

**Texas**—Gulf States Utilities Co., J. G. Holtzclaw, V. Pres., Beaumont, plans extensions and improvements to power plants and power lines at Beaumont, Orange, Hull, Jasper and Port Arthur, also rebuilding ice plants at Orange and Port Arthur; constructing sub-station at Beaumont and increasing generating capacity of gas plant at Lake Charles, La. Estimated total cost $870,000. Private plans.

**Tex., Graham**—City is having plans prepared for the construction of a waterworks system including dam, pumping plant, mains, etc. Hawley & Freeze, Capps Bldg., Fort Worth, are engineers.

**Tex., San Antonio**—San Antonio Public Service Co., c/o E. H. Kifer, Gen. Mgr., 201 North St. Marys, plans to appropriate $650,000 for improvements to natural distribution system including booster unit, etc. Private plans.

**N. B., Campellton**—Royal Fisheries Comn., Dept. of Marine & Fisheries, Ottawa, plans the construction of a cold storage plant here. Estimated cost $500,000.

**N. S., Halifax**—Nova Scotia Framway & Power Co. Ltd., K. L. Dawson, Engr., plans the construction of a coking plant. Estimated cost $160,000.

**Ont., Hamilton**—Bank of Montreal, H. O. James St., Montreal, Que., is having plans prepared for a bank and office building including steam heating system, elevators, etc. at Main and James Sts. here. Estimated cost $600,000. K. G. Rea, 1111 Beaver Hall Hill, Montreal, Que., is architect.

**Ont., Port Arthur**—Utilities Comn., is having plans prepared for the construction of a transformer station. Estimated cost $60,000. T. F. Milne, City Hall, is engineer.

**Ont., Toronto**—T. Eaton Co. Ltd., H. O. Queen & Yonge Sts., plans the construction of a 5 story department store at Calgary, Alta., and an 8 story department store at Saskatoon, Sask., both including steam heating system, elevators, etc. Estimated cost $500,000 and $600,000 respectively. Architect not selected.

## Equipment Wanted

**Boilers, Turbines, Condensers, etc.**—Oklahoma Gas & Electric Co., Insurance Bldg., Oklahoma City, Okla., plans the installation of new boilers, steam turbines, condensers and auxiliary equipment for rebuilding of Noble Street power station. Estimated cost $150,000.

**Condenser, Feed Water Heater, etc.**—Bd. of Public Service, J. Pritchard, Dir., Room 208, City Hall, St. Louis, Mo., will receive bids until Feb. 14 for one deaerating feed water heater and condenser with integral water meter, etc., in municipal service building.

**Conveying Elevating Machinery**—Certainteed Products Corp., Richmond, Calif., plans to purchase conveying elevating machinery for proposed addition to plant. Estimated cost $110,000.

**Engine**—H. F. Hessel, Connel Meat Market, Connel, Wash., plans to purchase a 60 hp. Diesel engine direct connected to 3 ph., 60 cycle alternator and switchboard.

**Generator Set** — Engineers Office, War Dept., Washington, D. C., plans the installation of a 50 kw. turbo electric generator set at St. Louis, Mo.

**Motor Control Equipment** — G. Gross, County Clk., Oakland, Calif., will receive bids until Feb. 6 (extended date), for motor control equipment for ventilating fans for Oakland and Alameda Estuary subway project.

**Power Equipment**—Bureau of Light & Power, Los Angeles, Calif., plans to purchase equipment to cost $150,000 for proposed distribution station.

**Pump**—City of Great Falls, Mont., plans to purchase a high duty pump for proposed waterworks improvements, estimated cost $36,000.

**Pump** — Grand Rapids Gas Light Co., Grand Rapids, Mich., plans to purchase a distribution booster gas pump for proposed extensions and improvements to plant. Estimated cost $300,000.

**Pumps**—Borough of Essex Fells, N. J., M. VanDien, clk., Borough Hall, will receive bids until Jan. 27, for two No. 5 H 351 A Worthington horizontal split case double suction volute pumps to deliver 700 g.p.m. against a total head of 200 ft. each, equipped with two fifty B.H.P. Crocker Wheeler frame 15 R three phase 60 cycle, 220 volt, 1,700 R.P.M. squirrel cage motors with hand starting compensators.

**Pump, Motor, Etc.**—L. A. Buchanan, Clk., Coalings, Calif., will receive bids until Jan. 30 for a 750 g.p.m. deep well turbine centrifugal direct connected to motor with automatic control.

**Pump and Motor** — City of Coalinga, Calif., will soon receive bids for a pump and 60 hp. motor for waterworks system.

**Pump and Motor** — Town of Mountain View, Okla., plans to purchase a 100 g.p.m. centrifugal pump and a 10 hp. motor.

**Pumping Equipment** — City of Columbia, Ill., plans to purchase pumping equipment, etc., for proposed waterworks improvements.

**Pumping Equipment** — City of DeKalb, Miss., will receive bids until Feb. 10 for pumping equipment, etc., for proposed waterworks improvements.

**Pumping Equipment, etc.** — City of Houston, Tex., O. F. Holcombe, Mayor, will receive bids until Feb. 1 for sludge pumping and motor equipment, also 16 in. Venturi meter with recording instruments for North Side, sewage disposal plant.

**Pumping Units**—City of Menard, Tex., R. M. Heyman, Mayor, will readvertise for bids soon for three horizontal direct connected electric driven pumping units for proposed waterworks improvements. Former bids rejected.

**Pumps**—Dept. of Mental Hygiene, L. M. Farrington, Secy., Capitol, Albany, N. Y., will receive bids until Feb. 8 for pumps, etc. for fire protection for Rome State School, Rome, N. Y.

**Refrigeration Equipment** — Silverwood Ltd., London, Ont., prices and catalogs on refrigeration equipment for proposed pasteurization plant at Fergus, Ont. Estimated cost $60,000.

**Transformers, Etc.** — Hamilton Hydro Comn., City Hall, Hamilton, Ont., plans to purchase transformers, etc., for proposed improvements to electric system, estimated cost $21,400.

**Transformers, Meters, Etc.**—Central Power & Light Co., E. B. Neiswanger, Frost Bldg., San Antonio, Tex., plans to purchase transformers, meters, etc. for proposed improvements to system at Laredo, Tex. Estimated cost $45,000.

**Turbo Generator Unit and Boiler Equipment**—San Antonio Public Service Co., E. H. Kifer, V. Pres. and Gen. Mgr., St. Marys St., San Antonio, Tex., plans the installation of a 30,000 kw. steam turbo generator unit with boiler equipment at Comal plant, New Braunfels, Tex., estimated cost $500,000.